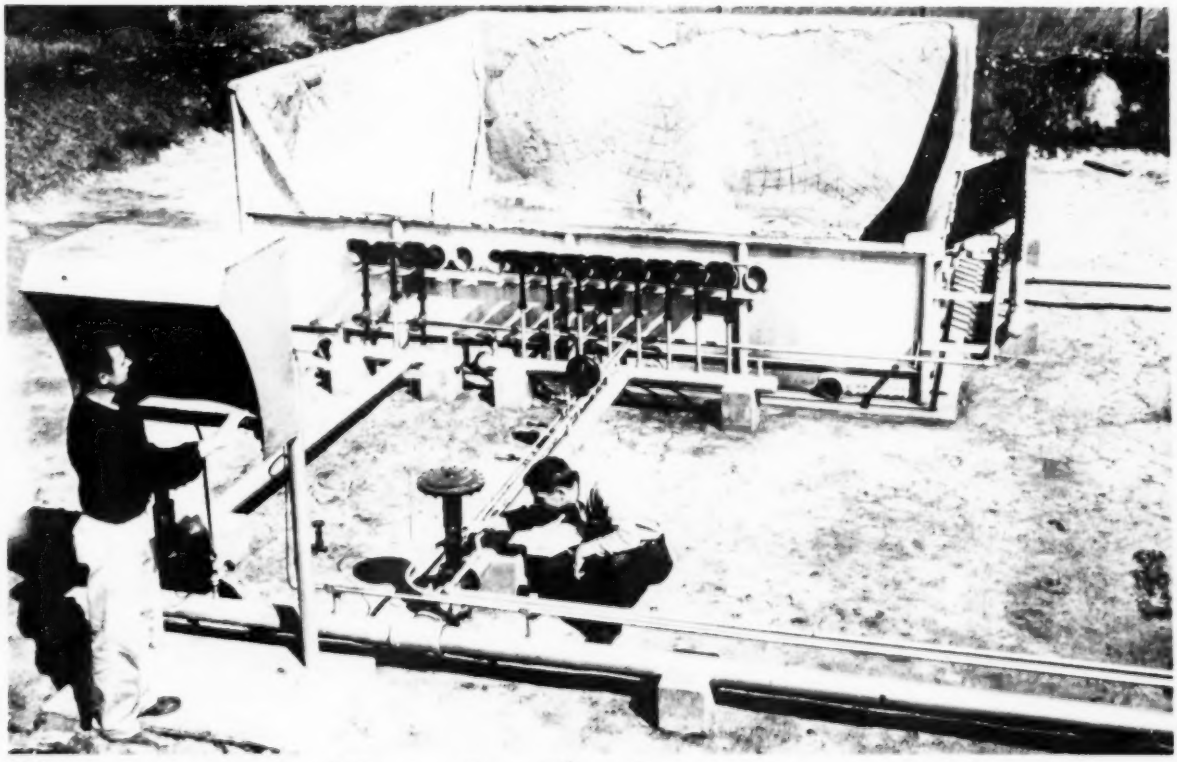
PETROLEUM PROCESSING

including Petrochemical Processing Section

AUGUST 1953



Want a Low-cost Waste Gas Flare? You can build one like this for less than $5,000. It's on the ground, so you save stack costs—p. 1162

Octane Predictions for end-1954

Accent is on premium. 93 Research foreseen as U. S. average—p. 1157

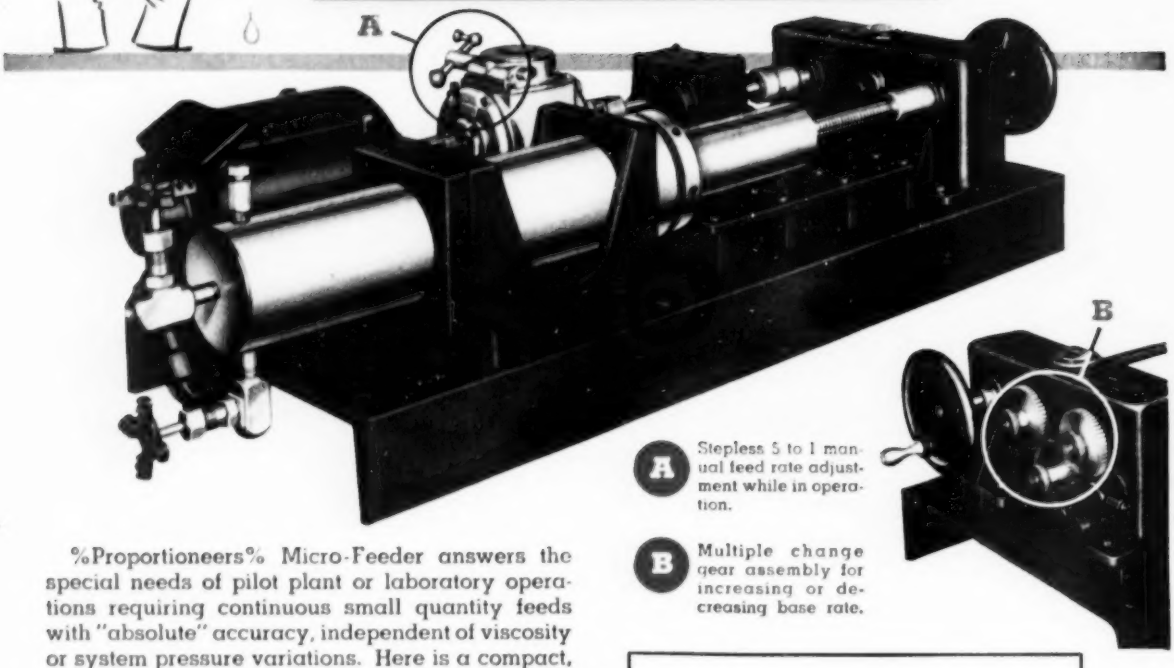
Drier and Cleaner Coke Products

How one refinery uses a mechanical system for de-watering—p. 1170

A McGRAW-HILL PUBLICATION

FOR MICROMETER ACCURACY IN FLUID FEEDING

AT CONSTANT RATE OR FLOW PROPORTIONALLY



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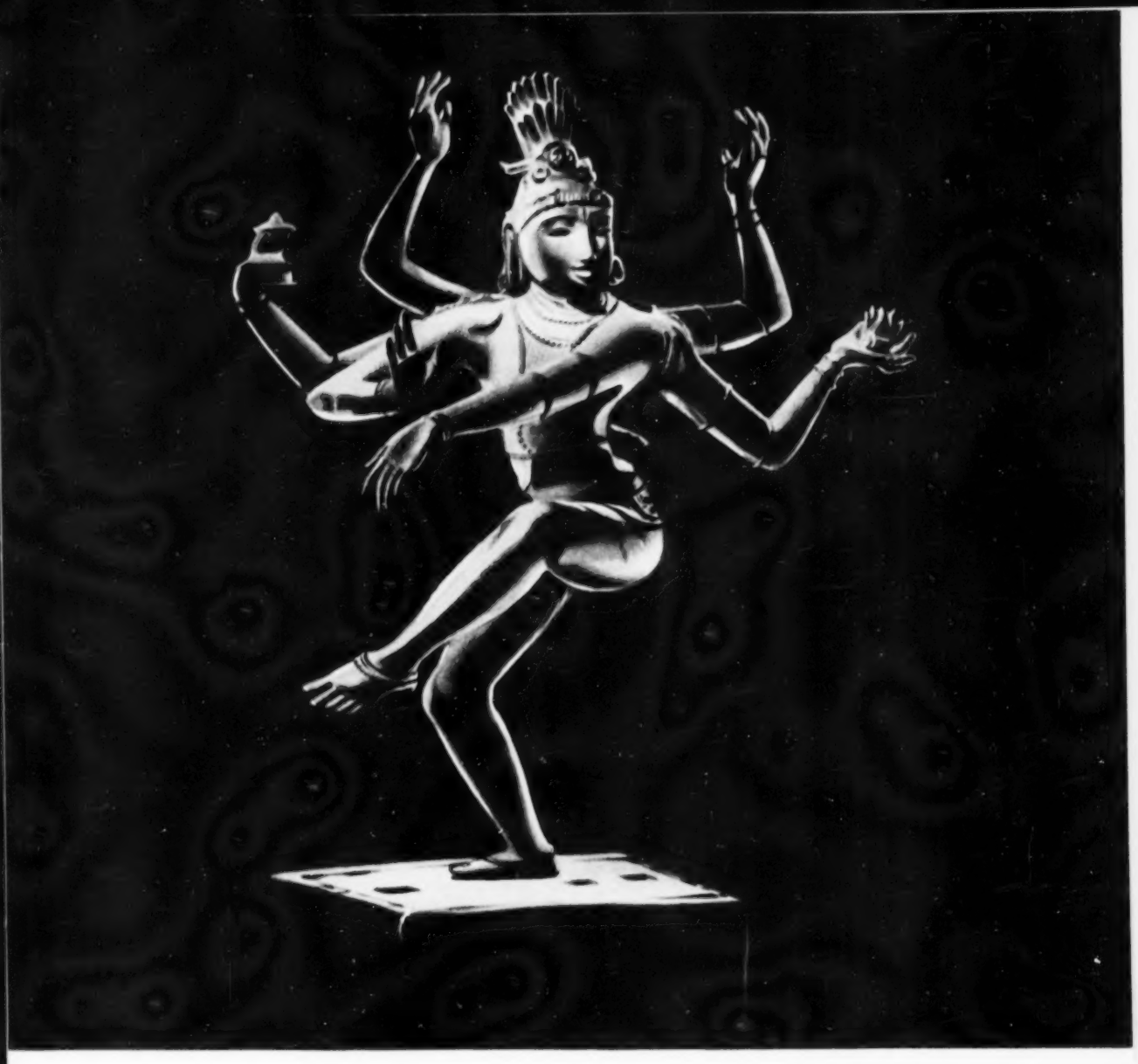

We're always glad to lend you a helping hand

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In thirty years of working with the petroleum industry, we have built up a powerful advertising arm, which was one of the decisive factors in stimulating public demand for premium gasoline, and is today helping you increase sales of this extra quality product. And we've backed up this arm with another which fashions movies, booklets, demonstrations, and other selling aids to help your service station people increase premium sales.

Then there's the Ethyl research arm which helps you squeeze the highest

(*Continued on next page*)

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We're always glad to lend you a helping hand

(Continued from preceding page)

possible octane number out of every ounce of TEL. And a gasoline testing arm which helps you measure and maintain the quality of your gasoline.

Our farm-program arm helped to develop an entirely new market for gasoline, and continually works to increase the size of this market.

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Dewaxing Aid	Ethyl Ether	Butadiene
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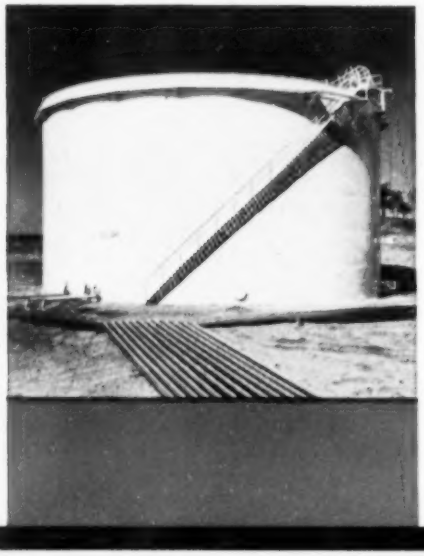
(To obtain more data on advertised products see page 1232)

the important factors in **floating roof design**

number 3 of a series



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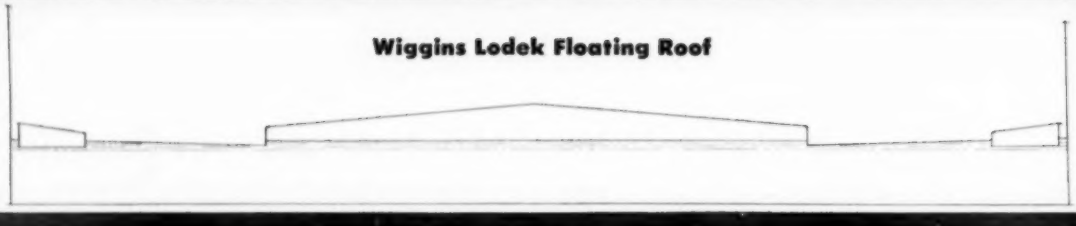

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PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels lubricants and chemicals.

August, 1953
Vol. 8, No. 8

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PUBLICATION OFFICES
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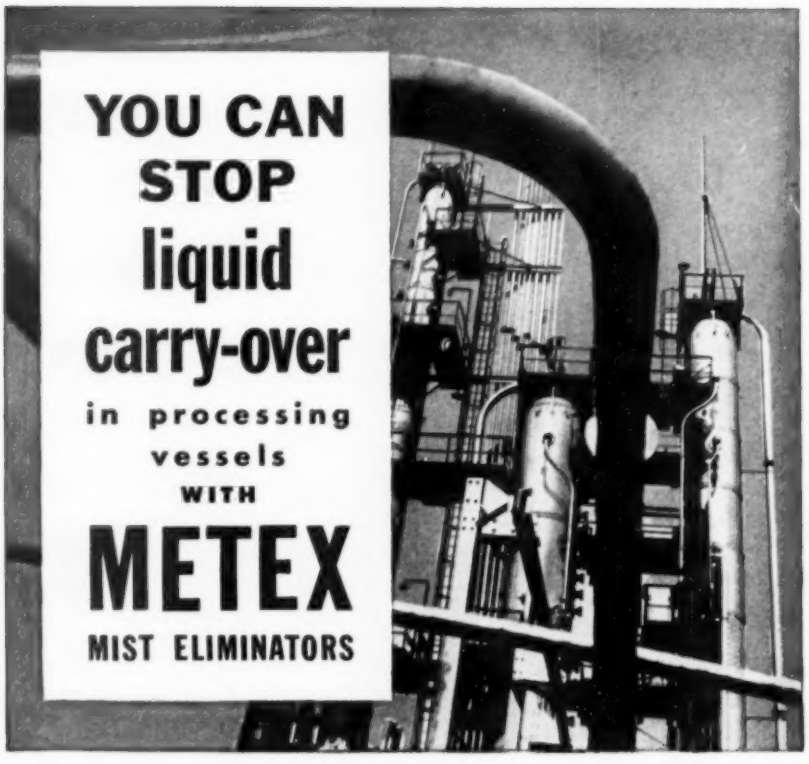

YOU CAN STOP liquid carry-over

in processing vessels WITH

METEX

MIST ELIMINATORS

The unusually high efficiency with which these *knitted* wire mesh units remove the liquid entrainment that occurs in a wide variety of refining and processing operations has enabled engineers to:

1. Improve product quality and eliminate reruns.
2. Prevent contamination in subsequent operations.
3. Recover valuable products previously lost.
4. Operate existing equipment at higher capacities.
5. Design new equipment with smaller dimensions.
6. Achieve more economical processing of lower grade materials.
7. Secure longer "on-stream" periods by removing corrosive liquids.
8. Prevent air pollution by objectionable liquids.

METEX Mist Eliminators can be used *wherever* the problem of liquid entrainment exists. By effecting complete removal of liquids, Mist Eliminators contribute to more efficient and economical processing in such vessels as:

VACUUM PIPE STILLS	EVAPORATORS	COMPRESSORS
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Get the full facts on METEX Mist Eliminators

Write for bulletins giving detailed information — including limiting velocities, pressure drop, efficiencies, etc.

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METEX

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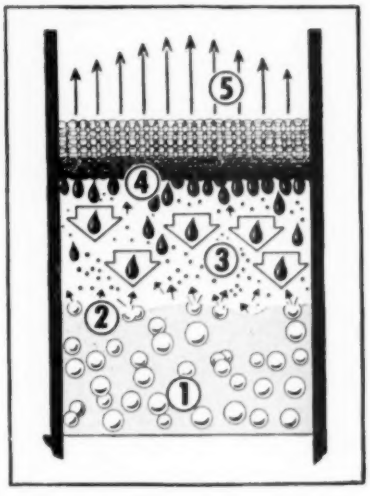
Advertisement

PADS OF KNITTED WIRE MESH WIPE OUT LIQUID ENTRAINMENT

Pads of uniform density, made from multiple layers of knitted wire mesh, have proved exceptionally effective in removing liquid entrainment from gases in a wide range of refining and processing operations.

The pad is placed inside a vessel above the liquid level. Its construction provides a multiplicity of unaligned, asymmetrical openings with unusually large wire-surface area. It is impossible for a gas to pass through the pad without continually changing direction; yet the high free volume—97 to 98%—minimizes restriction and pressure drop.

METHOD OF OPERATION



When a gas is generated in or passes through a liquid (1), it carries with it, as it bursts from the liquid surface (2), a fine spray of droplets of entrained liquid. These droplets are carried upward by the rising gas stream (3).

As the gas passes through the pad, the droplets impinge on the extensive wire surface (125 square feet of area per cubic foot of pad volume). The droplets coalesce on the wire surface to form large drops of liquid which break away (4) from the wire mesh and fall back against the gas stream. The gas (5) passes on, freed from liquid entrainment.

AVAILABILITY

The pads, which are known as METEX Mist Eliminators are made by Metal Textile Corporation, 631 East First Avenue, Roselle, N. J. A bulletin giving detailed information is available on request from the manufacturer.

PETROLEUM PROCESSING

Publisher's Page

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Why We Don't Publish Many Meeting Papers

OCCASIONALLY readers, and sometimes even authors, buttonhole us to ask how we decide what to do with the papers delivered before technical meetings of the oil industry and other associations. This space is taken up, this month, to explain the fundamental editorial policy of PETROLEUM PROCESSING and how it relates to the publishing of full texts of meeting papers.

We can best lead off by stating that TIMELINESS is the basic yardstick for the selection and preparation of copy, for both feature articles and regular departments. As editors, we are concerned mainly with new processes, methods, procedures and equipment and how they may affect future operations in petroleum processing plants. Most of this type of material has to be gathered by staff writers who are alert as to what is going on and sufficiently mobile in thoughts and action to round up material, check data and prepare their articles promptly. When outside writers are assigned special topics, it is because of their greater knowledge in a particular field.

By comparison, scientific papers presented before association meetings, by their nature have to be something of a general broad review of a subject. Topics and writers are assigned several months ahead of the scheduled presentation of the paper. Authors do an immense amount of preparatory work before writing, and what they say is backed up by the available experience and factual data from the operations of their own and possibly other companies.

Thus, the work involved and the time consumed in preparing meeting papers results in their seldom carrying the *first* information on new processes and methods. Editors of PETROLEUM PROCESSING have generally rounded up, at an earlier date, what information was available on these matters, and passed it on to readers while it was timely. Meeting papers are always studied and briefed, reviewed or commented on in some way, to give additional data on what has been published earlier. For example, an article in this issue (p. 1157) presents some data from a paper given before the API more than a year ago, because of its significance in the *current* discussion of trends in motor fuel octane ratings. There are exceptions, of course. Some meeting papers are such important contributions to the technical knowledge in a given field that they are selected for publication in full.

The tempo of technical developments in the petroleum processing industries is more rapid today than ever before. We believe that, in the main, we can best serve our readers by keeping our decks clear to pass along the current technical happenings in our industry as promptly and completely as we can.

Virgil Guthrie

For the Editors

Other Platt Petroleum Publications

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The weekly oil marketing magazine, covering news, prices, transportation, storage, merchandising.

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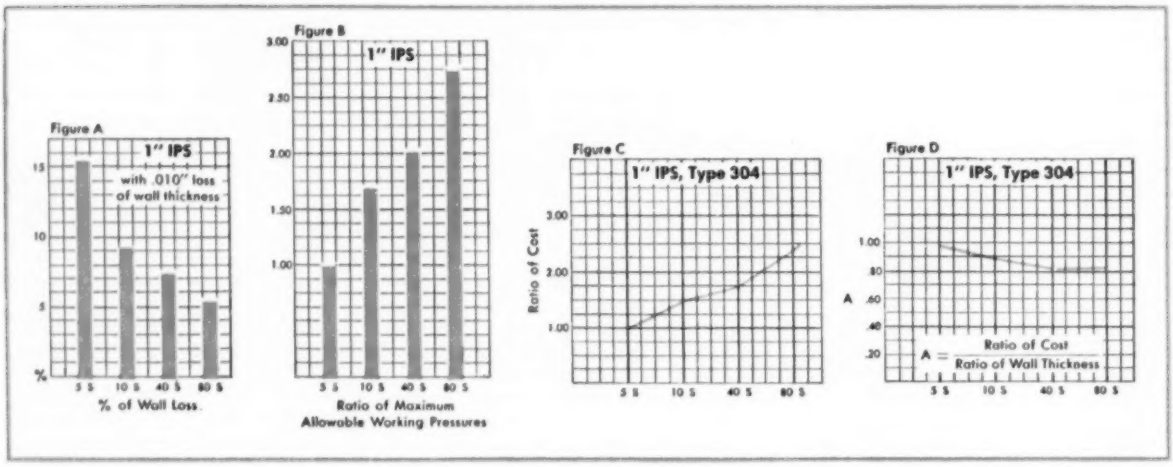
A daily independent oil-news reporting service issued from New York, Cleveland and Houston

Platt's Oilgram Prices
A daily independent oil-price reporting service issued from New York, Cleveland and Houston

take a closer look at

Stainless STEEL PIPE SIZE Schedules

Don't be "penny wise and pound foolish" where stainless steel piping is concerned. The most economical choice does not always imply the least initial cost as working pressure, methods of joining, installation costs and allowance for loss by corrosion are critical factors. This is particularly true where costs resulting from failures in service—replacement of equipment and lost production due to down time—may exceed the initial cost of the piping.



CORROSION RESISTANCE

For long service life it is advisable to allow for some loss in wall thickness where stainless piping is employed to combat severe corrosion. As shown in Figure A even a small loss means an appreciable percentage loss of wall thickness in the lighter weight schedules.

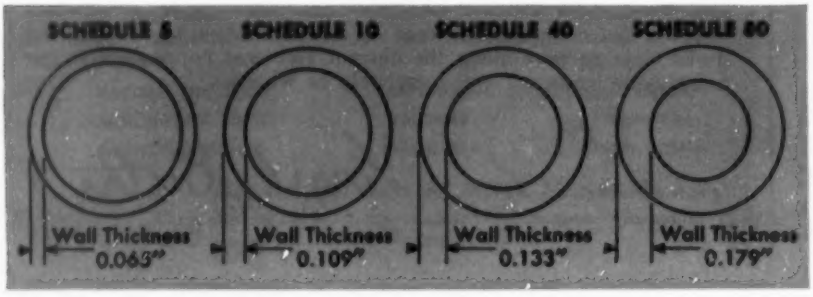
WORKING PRESSURES

As shown in Figure B, the heavier pipe schedules permit higher working pressures, thus perhaps permitting the use of smaller diameter piping, or offering greater flexibility for subsequent changes in operational procedures.

COSTS

Although the lighter schedules cost less, as shown in Figure C, you actually get more for your money with the heavier schedules because the ratio of increase in cost is *less* than the ratio of increase of wall thickness (Figure D).

1" IPS



Methods of Joining & Installation Costs

From the standpoints of economy and ease of installation, it is extremely important that attention be given to methods of joining, fittings, etc. because:

1. Schedule 40 IPS is the lightest weight pipe specifically designed for threading.
2. Fittings which provide a good thread and also afford structural strength at the joint are not commercially available for lighter weight pipe.
3. Field welding of thin wall pipe is difficult.
4. Misalignment of connections can cause high installation costs.

While various types of fittings are available for the lighter weight pipe schedules, they should be examined carefully as to initial cost, installation cost, working pressure permitted and ease of adaptation to existing lines.

Whatever your stainless piping problems, Mr. Tubes—your B&W Tube representative—can provide valuable assistance. Consult him for advice on the stainless piping or tubing that will afford optimum cost-life ratio under your service conditions.

TA-1709(G)

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TUBULAR PRODUCTS DIVISION

Alliance, Ohio—Welded Carbon Steel Tubing
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing

What's Happening . . .

Refinery Expansion

. . . **Pan American Refining Corp.** will build a 21,000 b/d catalytic reformer at its Texas City refinery, using a fixed bed process developed jointly with Standard Oil Co. (Indiana). Details not yet announced. M. W. Kellogg is contractor. The project is part of a general expansion of the Texas City refinery.

. . . **Sinclair Refining Co.'s** 16,000 b/d reforming unit, announced this spring for its Marcus Hook refinery, has been approved for rapid tax writeoff. Total cost is $14,400,000. The plant will use a new fixed bed method and a platinum catalyst developed by Sinclair Research Laboratories and Baker & Co., Inc., chemical firm.

. . . **Baker & Co.** has started construction of a $2,500,000 plant at Newark, N. J. to make the new platinum-containing catalyst. (See pg. 1157 for article relating catalytic reforming to manufacture of high octane motor gasolines.)

. . . **Williston Basin Refining Co.** will erect a 1500 b/d refinery at Williston, N. Dak. Facilities will include catalytic reforming, gas recovery, utilities, tankage and other facilities of a complete refinery. Company was recently formed by Williston group headed by R. Mowdy, Williston, as president. Koch Engineering Co. is engineering contractor.

. . . **Caribbean Refining Co.** will build in San Juan, Puerto Rico's first petroleum refinery, of 10,000 b/d capacity, to cost more than $10,000,000. Facilities will include crude and vacuum distillation, fluid catalytic cracking, catalytic polymerization and gas recovery. Gasoline, distillates, fuel oil and LPG will be produced. The Puerto Rico Water Resources Authority will take its fuel oil requirements from the plant for 10 years.

The refinery will be built by Fluor Corp., Ltd. and will operate under license from Universal Oil Products Co. Principal stockholders of Caribbean Refining are Pontiac Refining Co.; Gulf Oil Corp.; Cosden Petroleum Co.; Emby Kaye, Tulsa; J. H. Whitney & Co. and H. M. Byllesby, of New York.

. . . **Deep Rock Oil Corp.'s** new $2,500,000 lube oil plant at its Cushing, Okla., refinery is in operation. Unit has finished products capacity of 950 b/d and combines propane deasphalting with phenol solvent refining. M. W. Kellogg Co. designed and built the plant; Refinery Engineering Co. the tankage, cooling tower and other off-site facilities. Lube plant is part general refinery expansion program launched in 1949.

. . . **Danaho Refining Co.** will increase capacity of its 5000 b/d plant at Pettus, Texas to 8500 b/d by revamping crude distillation facilities and will install 5000-bbl. Type 20 Socony-Vacuum TCC unit having concurrent reforming facilities. Included in $2,670,000 expansion, (Certificates of Necessity) are gas recovery unit and additions to catalytic polymerization and utilities. Koch Engineering Co. has design and engineering contract.

. . . **Standard Oil Co.** (Ohio) has broken ground for its new 12,000 b/d Platforming unit at Lima, Ohio. Cost is $7,500,000. Procon, Inc. is the general contractor.

. . . **Ohio Oil Co.'s** new 6000 b/d coking unit, designed and built by Lummus Co., was scheduled to go on stream August 1. New 7000 b/d Houdriforming unit, another part of current expansion, is expected to be complete February, 1954.

. . . **Continental Oil Co.** plans a $1,500,000 expansion at Gillis natural gasoline plant near Lake Charles, La., increasing throughput from present 27,000 MCFD to 90,000 MCFD. Liquid products will go up from 13,000 to 87,000 gal/day. Hudson Engrg. Corp. has construction contract with completion scheduled for early 1954. Liquid make, now largely butane and natural gasoline, will be a mixed stream including propane, to be sent to firm's Lake Charles refinery for fractionation and marketing.

. . . **New petroleum processing plant expansions** to look for, as indicated by rapid tax amortizations announced last month:

Gulf Refining Co., $5,631,820 for natural gasoline facilities at St. Landry Parish, La.

Mid-Continent Petroleum Corp., $2,413,322 for refining facilities at Tulsa, Okla.

Sunray Oil Corp., $942,600 for natural gas facilities in Bossier Parish, La.

International Refineries, Inc., $9,560,900 for 10,000 b/d combination unit, other facilities, Carlton County, Minn.

Caminol Co., $1,662,754 for cat cracking, gas recovery, cat polymerization, and auxiliary units, Hanford, Calif.

Warren Petroleum Co., $142,234 for isobutane fractionation, Greggton, Tex.

Shell Oil Co., $1,587,000 for natural gasoline plant expansion, Elk City, Okla.

Phillips Petroleum Co., $525,000 for natural gasoline plant depropanizers and compressors, Alvin, Tex.

Petrochemicals

. . . **Mill Creek Chemical Co.,** newly formed, with Dallas interests participating, will build a $9,000,000 anhydrous ammonia plant near Salt Lake City. Using pipeline natural gas, it will produce 180 tons of ammonia and 30 tons of dry ice daily. Products will be marketed through established distributors in nine Rocky Mountain and West Coast states. Plant will be designed by Tears Engineers and built by Henry C. Beck Co., both of Dallas.

. . . **Matholin Corp.,** newly organized, will manufacture, sell and carry on research in hydrazine, a rocket fuel ingredient also used in agricultural, plastic and other chemical products. Owned equally by Olin Industries, Inc., and Mathieson Chemical Corp.,

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

Matholin will operate the first commercial-scale hydrazine plant in the U.S., recently completed by Mathieson at Lake Charles, La., as part of its chemical manufacturing facilities there. The process used is a modification of an earlier synthesis which reacts ammonia with sodium hypochlorite.

. . . **The name Olin Industries, Inc.,** will become familiar in the petrochemical field. Through purchase of control of the Interstate Natural Gas Co., Monroe, La., from Standard Oil Co. (New Jersey), Olin now has facilities to develop mineral resources on 455,000 acres in East Texas, Arkansas and Louisiana. Headquartered in East Alton, Ill., with plants over the country, the company is active in the explosives, lumber, paper and other manufacturing industries. John M. Olin, president, is a pioneer researcher into hydrazine and certain derivatives used as explosives.

. . . **Celanese Corp. of America,** will become major suppliers in the U.S. of pentaerythritol; produced at the Edmonton, Alberta, plant of its affiliate, Canadian Chemical Co., Ltd. The compound, used mainly for alkyd resins for paints, is made from acetaldehyde and formaldehyde produced at the Edmonton plant from petroleum hydrocarbons, by a new continuous process developed by Celanese at its Clarkwood, Texas, chemical research laboratories.

. . . **American Cyanamid Co.** has developed to pilot plant stage a process for the manufacture of anthraquinone from naphthaquinone and butadiene. Known in the laboratory for some time, improvements in the manufacture of the naphthaquinone and its conversion to anthraquinone may make the process commercially feasible. In this country, anthraquinone has been made primarily by the phthalic anhydride-benzene route; in Europe by oxidation of anthracene.

. . . **New petrochemical projects in the wind,** as indicated by rapid tax amortization approvals granted last month by Office of Defense Mobilization:

Phillips Chemical Co., $2,039,000 for carbon black manufacture at Borger, Texas.

Sinclair Refining Co., $14,400,000 for rehabilitation of toluene extraction, 16,000 b/d catalytic reformer, and auxiliaries, Marcus Hook, Pa.

Markets, Prices

. . . **Refiners in some areas found the going rough** in their efforts to hold refined products prices at the higher levels quoted following the mid-June advance in crude oil postings.

. . . **Distillate fuels dropped back** 0.1 to 0.25c gal. in two of the nation's largest primary supply markets—the Gulf Coast and New York harbor—and there was widespread discounting of quoted prices in the Mid-Continent and Chicago Districts under the pressure of mounting inventories and slack summer-fill demand.

. . . **Gasoline prices likewise** were subject to "shading" in several refinery districts. Position of lubricating oils also could be described as "shaky". On the other hand, residual fuels appeared to be firmest in the refined oil list.

Prices down to 9c a gal. for kerosine and 8c for No. 2 fuel were reported in the Gulf cargo market late in July (most refiners had advanced to 9.5c and 8.5c following the boost in crude), but as the month ended No. 2 fuel had snapped back to low of 8.25c. At New York harbor, same product was offered 0.25c lower at 8.9c in barge lots.

It took nearly all of July for uncertainty in the world crude oil market to be dispelled, but by the end of the month postings had been advanced in Canada, Venezuela and the Middle East to reflect the 25c boost in U.S. crude prices.

Market Outlook

. . . **True status of refiner's stocks** of heating oils (distillates and kerosine) may not be learned until well into September. Replenishing of distributors' stocks seems delayed, particularly in the East, which normally pulls on refinery stocks by this time. Stocks east of California in mid-July were only 13.5% larger than in 1951. Increase in consumer demand this winter is placed at 8-10% above last.

Continuing heavy gasoline demand is expected. Gasoline output at refineries, though, is at a rate that is slowing down reduction in stocks.

. . . **Any dropoff in military demand** for petroleum products following Korean armistice will show up first in higher grade avgas for reciprocating type engines. PAD might be able to rescind its order requiring use of TEL in commercial avgas and perhaps later its order prohibiting use of alkylates in motor gasoline. Long view is that defense buildup of our military establishment will increase general demand for petroleum, particularly jet fuels.

Miscellany

. . . **Standard Oil Development Co.'s** new continuous coking process will shortly by made available to the industry under license. It may be announced the middle of August. The process, which uses a fluidized solids technique, has been through the pilot plant stage of development at Baton Rouge, La.

. . . **Three additional compounds** are now available as API standard samples of hydrocarbons; 2,3- Dimethyl-1-pentane; Ethenylcyclohexane (Vinylcyclohexane); 1,4-Diisopropyl-benzene. They can be secured through the Petroleum Research Laboratory, Carnegie Institute of Technology, Pittsburgh. A total of 215 pure compounds are now available for laboratory reference and other test uses.

. . . **API directors in September** will set Jan. 1 as the day for the oil undustry to swing over to the new ASTM-IP Petroleum Measurement Tables, replacing Circular 410 of the National Bureau of Standards as the standard reference for volume and other conversion factors. In the interim oil companies are urged to secure copies of the new tables, revise their contracts to show the new standard reference and acquaint their accounting staffs with the use of the manual.

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Santolube additives can be blended with your base stocks to help them meet requirements of "hot" engine operation of trucks and heavy duty equipment, or "cold" engine operation of passenger car service—or both.

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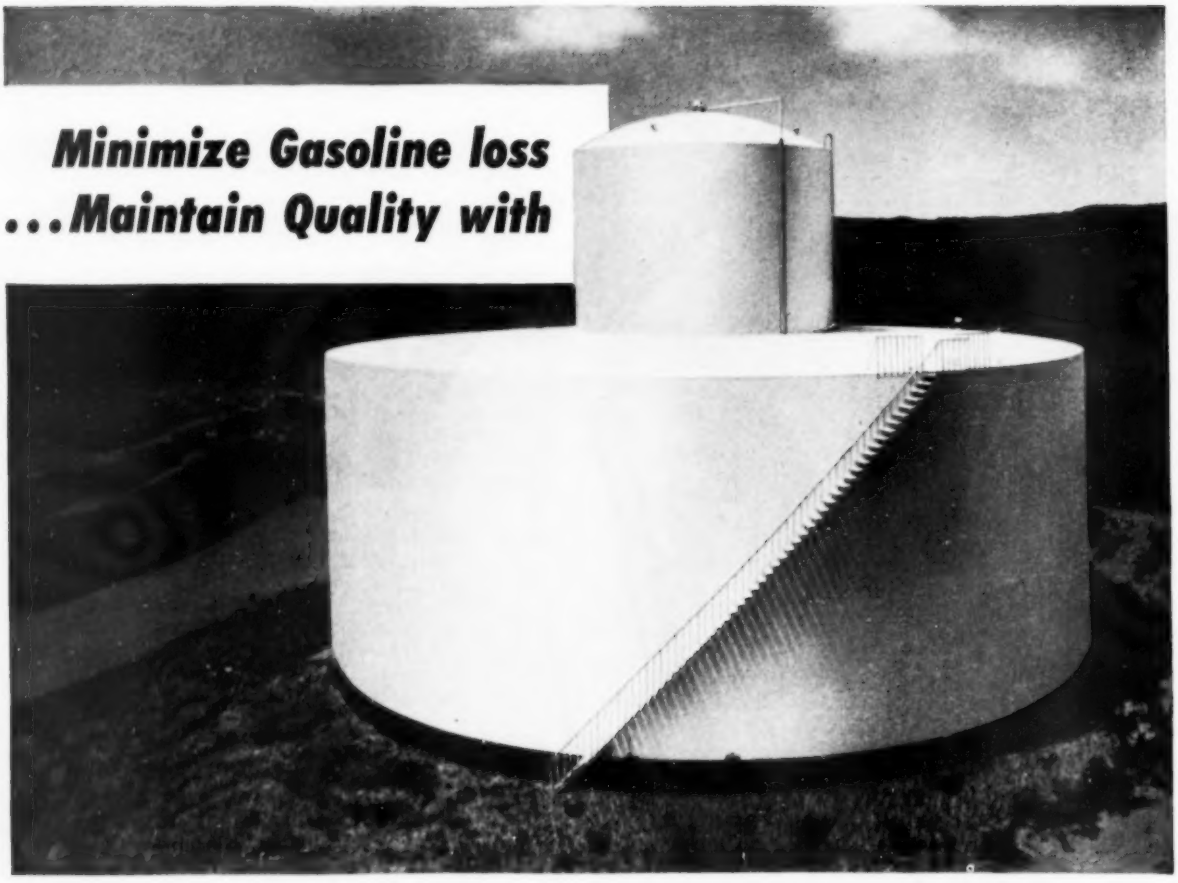

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Unnecessary gasoline vaporization can often mean the difference between profit and loss! With the VAPOR-MIZER, standing losses are eliminated and filling losses minimized. The time-tested VAPOR-MIZER system means *positive* vapor control. What's more, because it requires less steel to build, and uses smaller, less expensive vapor lines, the VAPOR-MIZER costs less than other conservation designs. Since it operates at extremely low pressures (less than one ounce) the reinforcement of manifolded tanks is unnecessary.

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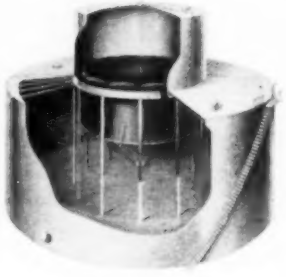

THE VAPOR-MIZER IS DESIGNED TO:

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- Readily convert older, existing tankage

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More Companies in the Payoff On the API Research Projects

MORE oil companies and engineering firms are discovering that the data being developed in the Fundamental Research Projects of the American Petroleum Institute can be put to practical use by their technical staffs. Application of the data on composition and properties of petroleum hydrocarbons in some specific research and design problems, for example, has saved many man hours of work earlier spent in looking up such information as was available.

The usefulness of the data has been greatly enhanced, in one project, by punching it into IBM cards, since most large organizations have IBM machines in their accounting departments and some concerns now have these machines in their laboratories for scientific work. The completion of the work of transferring the data to punch cards has been recently described[1] and some companies have already ordered sets of the cards, which are being provided at relatively low cost since the master cards have already been prepared.

The group which has adopted this modern technique for compiling and selecting extensive data and providing for its use on electronic calculating machines, is that associated with Project 44, Data on Hydrocarbons and Related Hydrocarbon Compounds. The work is located at Carnegie Institute of Technology, Pittsburgh, under the direction of Dr. Frederick D. Rossini, head of the school's Department of Chemistry.

For 10 years Project 44 has been concerned with collecting, analyzing, calculating and compiling selected values of physical and thermodynamic properties, and critically collecting and compiling infrared, ultraviolet, Raman and mass spectral data, all of hydrocarbons and related compounds, the report states. The tables of the project cover 935 different compounds and include more than 110,000 individual numerical entries. The data, which constitute the most reliable and comprehensive information existing for hydrocarbons and related compounds, is available on approximately 1000 loose-leaf sheets, as well as on punch cards. Associated in this work has been Project 6; Analysis, Purification and Properties of Petroleum Hydrocarbons, also under the direction of Dr. Rossini.

The importance of the data emanating from Project 44 has been recognized because much of it is fundamental in design engineering and in specific research work. Among the 11 projects now being carried on in the API Research Program are others which will certainly develop factual information of great practical value to petroleum and natural gas processing plants. Among these are Project 42; Synthesis and Properties of High Molecular Weight Hydrocarbons, of interest especially to lube oil manufacturers, and Project 48; Synthesis, Properties and Identification of Sulfur Compounds in Petroleum, which will provide data helpful to refiners in their treating problems.

For over 25 years the API has carried on a continuous research program directed at determining the fundamental data on the occurrence, recovery, composition and properties of petroleum, at a direct cost of not greatly over $5,000,000. The results are available to all interested parties. The eventual payoff will be at a high rate of return on this modest investment. —V.B.G.

(1) "API Research Project 44 Data on Hydrocarbons and Related Compounds Available on IBM Punch Cards"; a report by Jack Sherman, The Texas Co. Research Laboratories, Beacon, N. Y.

New Project Is Aimed at Finding Sound Equipment Replacement Policy

HOW often should a refinery pump be replaced? How frequently should a valve be finally discarded and a complete new unit put in? What is the optimum replacement schedule on equipment in general? Industry spends hundreds of millions of dollars annually replacing equipment, yet it really knows very little as to whether such expenditures are wise or not.

A long-term project now underway at Illinois Institute of Technology may provide the answers to some of these questions and help industry to spend its equipment replacement dollar more economically. Based on the sound premise that there is a general lack of knowledge in this field—and not indifference or management ignorance—the project has an excellent chance of succeeding. It has three major objectives.

1—To train people for industry. There will be both graduate and undergraduate courses in capital equipment and replacement and also conferences and seminars for industrial executives.

2—To conduct research in the application of equipment policy.

3—To inform industry of progress in the field.

The venture sprung from an idea the Machinery & Allied Products Institute has been working on for some time. Four years ago, this federation of trade associations in the industrial equipment field sponsored publication of a study, "Dynamic Equipment Policy," which classified about all there was then known on the subject. This study became a textbook in engineering economics.

This fall, the Illinois Tech program will begin, financed by MAPI and established as the National Center of Education and Research in Dynamic Equipment Policy. The school and the equipment Institute have a contract for five years, but it is expected that the program will continue indefinitely. Progress in engineering technology must logically always be measured with the dollar sign. —W.C.U.

Outlook Is Still Dim for Chemistry Bachelors according to ACS Survey

THE 1953 crop of graduates having bachelor's degrees in chemistry has taken a drop, with the same situation existing for those completing master's requirements, according to a survey recently made by the American Chemical Society. Counter-trending, approximately as many doctorates were conferred this Spring as in 1952.

The situation for bachelors will be worse next year,

Degrees in Chemistry, Granted and Estimated

Academic Year	B. Sc.	M. S.	Ph. D.
1948-49*	9,307	1,550	833
1949-50*	10,794	1,720	1,069
1950-51**	9,040	1,664	1,078
1951-52**	6,855	1,483	1,132
1952-43***	5,800	1,300	1,150
1953-54***	4,500	1,150	1,150
1954-55***	4,700		1,250
1955-56***	6,000		

* U. S. Office of Education data on chemistry and biochemistry.
** ACS survey data.
*** ACS estimates.

estimates based on the survey indicate, and likewise there will be a tapering-off in the number of candidates who will receive their master's. Doctoral graduates will not change significantly in the coming year, and the number is slated to increase in the 1954-55 academic year.

The worst trouble the ACS has in making estimates is the effect of calls from the armed forces and the uncertainty regarding the government's Student Deferment Program. Since the majority of enrollees are men, an artificially high "attrition rate" (number enrolled as seniors or candidates for advanced degrees less number of degrees actually conferred) is indicated, as many withdrawals undoubtedly are involuntary.

The accompanying table, taken from the ACS survey, shows the situation in more detail. From this, it would appear that the chemical and oil industries particularly will face the same or greater recruitment difficulties next year as last Spring, and that little relief may be expected before 1955.

This is borne out by enrollment data gathered in the ACS survey which shows that there were 5069 freshmen (men and women) enrolled for a full major in chemistry last November, 4228 sophomores, and 4347 juniors. These figures exclude reduced majors and part-time students. The ratio of men to women is approximately 4.5 to 1.

Another feature of the ACS survey is a geographical distribution of chemistry majors, comparing the number of graduates receiving degrees in that state compared with the number employed therein (this based on subscriptions to Chemical & Engineering News). New York leads with degrees conferred and chemical occupations, Pennsylvania following. The lowest in producing chemists is Wyoming; Idaho is next, and both have considerably more than the lowest state in employment. Vermont and Montana are tied as the states having the smallest number of chemical occupations. Tied for second place are New Hampshire and South Dakota, which produce three times more than the number of chemists who actually find occupation within their borders.

—D.P.T.

Will Research Meet the Challenge Of Aggravated Engine Wear?

THE trend toward higher compression and horsepower gasoline engines of compact design increases the severity of the conditions which cause engine wear. In the meantime, research work in the automotive laboratories of the oil companies is providing a greater fund of knowledge of the causes of wear of rings, cylinder walls and other engine parts, a necessary preliminary to the tailoring of motor oils to reduce this operating difficulty.

It will remain for the future to show how fully the oil companies meet the challenge, and save the nation's motorists part, at least, of the hundreds of millions spent annually to overhaul and replace engines which land in the shops due to damage from excessive wear.

An important contribution to our knowledge of the causes of wear from corrosion of the metal comes through the studies of Shell Oil Co. automotive technologists into the mechanism of ring wear induced by sulfur in the fuel.[1]

A survey of engine-overhaul shops in the San Francisco area showed that intermittent operation, where mileage was comparatively low, was the major cause of short engine life. A special laboratory technique was developed to study the theory that condensation occurs during the warm-up period of the engine, when jacket-water temperature is low, which causes corrosion and the wear of parts. Specifically, the effects of the sulfur compounds sulfur dioxide and sulfur trioxide in the fuel in conjunction with water condensation were studied.

Because the two acids, sulfurous and sulfuric, resulting from the dissolving of the compounds in the water condensate on the cylinder walls, "possess widely different chemical and physical properties, a knowledge of which acid is the major wear promotor should be of value in the development of methods to combat corrosive wear". On the basis of motored-engine tests, it was concluded that virtually all the corrosive wear caused by fuel sulfur is the result of water condensation in the presence of sulfur dioxide to form sulfurous acid.

The theory that sulfurous acid is the principal offender under average passenger-car operation is supported by other investigators. Reducing the operating time at low jacket temperature, and the use of compounded oils which conteract acidic attack are the principal methods of controlling engine wear, in the opinion of these authors.

Meantime, investigative work goes on by other authorities who have adopted the concept that the main source of engine wear is friction and abrasion between piston rings and cylinder walls, which increases engine clearances to the point where oil consumption becomes excessive and the engine must be overhauled.[2]

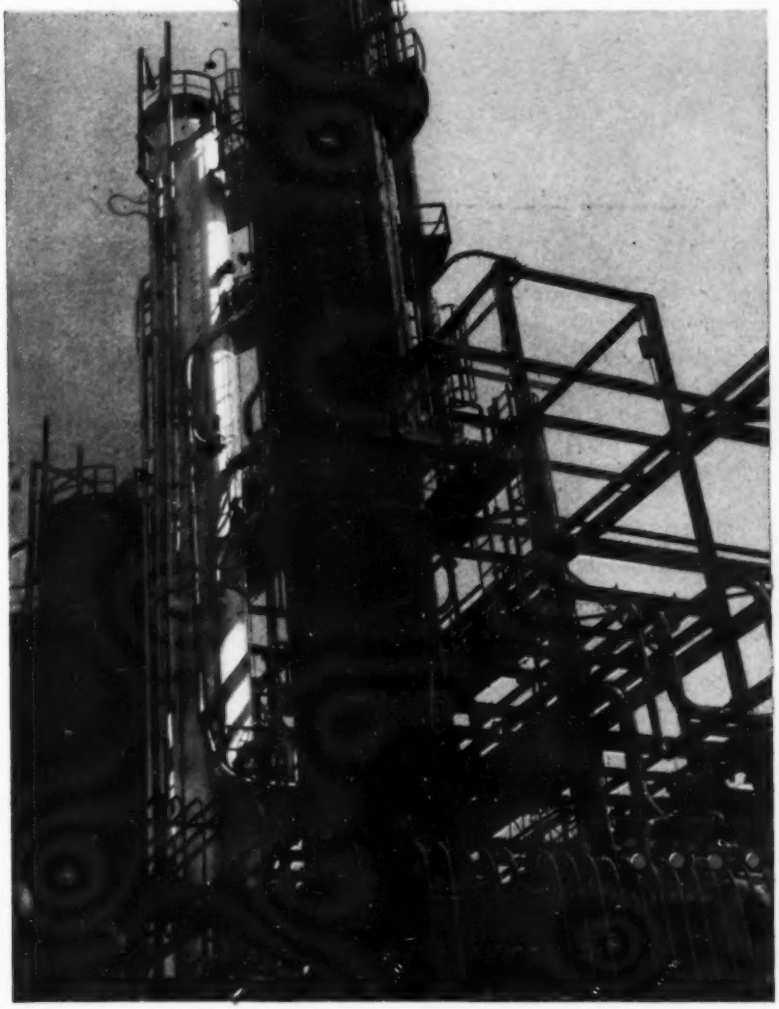
The complex nature of the mechanism of engine wear is becoming more fully appreciated, regardless as to whether the origin is believed to be in corrosion followed by abrasion of the corroded particles of metal, or starting from friction followed by corrosion of the particles removed through abrasion.

It is something like the question in biology of which came first, the egg or the chicken. In this case the answer is most important, for upon this ultimate finding will be developed the lubricants best fitted to relieve this cause of engine damage.

—V.B.G.

(1) "The Mechanism of Corrosive Wear in Passenger-Car Service," J. G. Ryan and B. W. DeLong, Shell Oil Co., Wood River; Paper presented before the 18th Mid-Year Meeting, API Division of Refining, New York, May 14, 1953.
(2) "Friction Main Cause of Engine Wear," PETROLEUM PROCESSING, September, 1952, pg. 1263.

Stainless Steel cuts tray plate cleaning in depropanizing tower of this polyform unit



HERE'S an example of the way Stainless Steel's corrosion resistance can stretch out the intervals between cleaning when used in refinery equipment.

Stainless Steel is now being used in the perforated tray plates in the depropanizing tower of the polyform unit at Gulf Oil Corporation's Port Arthur, Tex., refinery. The material formerly used for this purpose reacted with corrosive agents in the gas and the $^{3}/_{32}$" or $^{7}/_{64}$" perforations in the tray were plugged up after two to three months' use.

Then Stainless Steel was given the job. It has greater resistance to corrosion and, consequently, the intervals between cleanings are substantially longer.

Corrosion resistance is only one of the characteristics of Stainless that make it so suitable for refinery use. It is strong, its surface is dense and durable and it performs well in elevated temperature service. When you put all these advantages together, you can see why it is the most effective weapon against refinery down time.

For finest performance from Stainless equipment, always be sure that your equipment fabricator uses perfected, service-tested U·S·S Stainless Steel.

Depropanizing tower in the polyform unit at Gulf Oil Corporation's Port Arthur, Tex., plant. Stainless Steel, used in the perforated trays, has helped to lengthen the intervals between cleanings.

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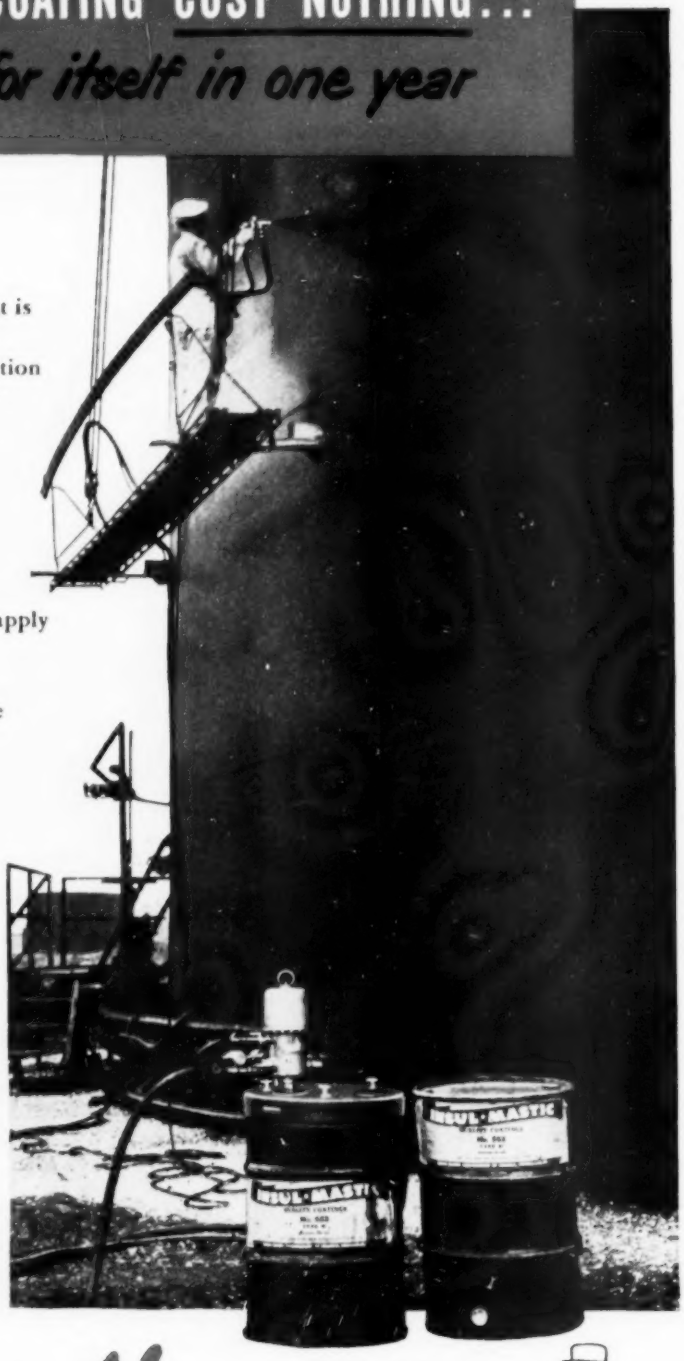

The photograph shows INSUL-MASTIC TYPE "D" being applied on an oil tank that is kept heated to retain free flowing viscosity. Within one year after the completed application this coating of INSUL-MASTIC TYPE "D" prevented enough heat from escaping from the tank to pay for the cost of the coating. It also prevented corroding of the tank.

INSUL-MASTIC TYPE "D" is a *Superior* quality corrosion preventive coating to which we add considerable cork. We then apply it ¼ inch thick. It is not intended to replace standard thermal insulation, but on vessels where moderate temperatures are maintained it stops much heat loss while preventing corrosion.

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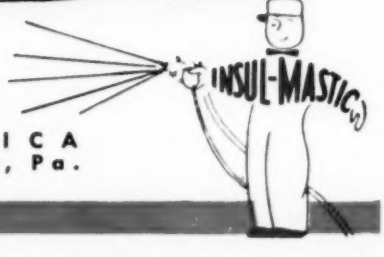

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Letters

Multicomponent Fractionation

. . . With Dr. White's extensive background in distillation, it is certain that you will have a good series of articles ["To Help You Design Fractionators," R. R. White, beginning in March, 1953, p. 357] and one with complete coverage of recent literature on this subject.

Regarding his first article, we do not see much advantage of the method proposed over standard tray-to-tray methods, which are certainly relatively easy for ternary mixtures. The graphical solution on triangular diagrams, which is not apparently proposed as the ultimate method of handling these problems, will be impractical because of the small range of the construction on ordinary graph paper. There are many of these sorts of methods in the literature.

JOHN HAPPEL
Professor and Chairman
Dept. of Chemical Engineering
New York University
New York 53, N. Y.

Electrical Equipment

We refer to the article, "Electrical Installations in Refineries" (April, pp. 527-529) and wish to advise you of corrections that should be made. In the first paragraph, the figure of 4000% should read 4500%. On page 529, it is stated approximately midway of the left hand column, that "It is evident from the work done so far that there is unanimity of thought . ." This should have read "It is evident from the work done so far that there is *no* unanimity of thought . . ."

LESTER M. GOLDSMITH
General Manager
Engrg. & Const. Dept.
Atlantic Refining Co.

Selecting Supervisors

. . . the most significant detail in the article ("Selecting the Best Supervisors." July, pp. 1013-1016) was the recognition early in their program that their problem should be diagnosed completely, and a specific design to meet their particular needs be developed.

The approach to supervisor selection, or to any one of innumerable similar problems in the operation of a large refinery should, in our opinion, be thoroughly diagnosed, and a tailor-made program should be developed to suit the peculiarities of the problem rather than reverting to the use of "canned" programs which, generally speaking, can fit only one out of ten situations . . .

E. L. SINCLAIR
General Manager
Socony Vacuum Oil Co., Inc.
Paulsboro Refinery

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When it comes to the planning of fire protection for your plant or business, there's considerably more to be viewed than the price. Of course, you will want to be fully informed on the economics of protecting your property, but it's equally important to know that the method of protection is the best available for any given area of your building.
It is for that reason that through the years we have not limited ourselves to the design and installation of only certain types of protection. Like you, we study the economic factors involved. Then, following a thorough investigation of all elements of your overall fire safety problem, we design, manufacture and install the type of protection best by test for maximum safety. It's engineered "Automatic" FIRE PROTECTION for you . . . the finest available at any price!
Why not find out how engineered "Automatic" FIRE PROTECTION can save dollars for your business whether you ever have a fire or not. Remember, what's worth insuring is worth protecting.
Write for Bulletin 66, the ABC of Fire Protection. It's FREE.
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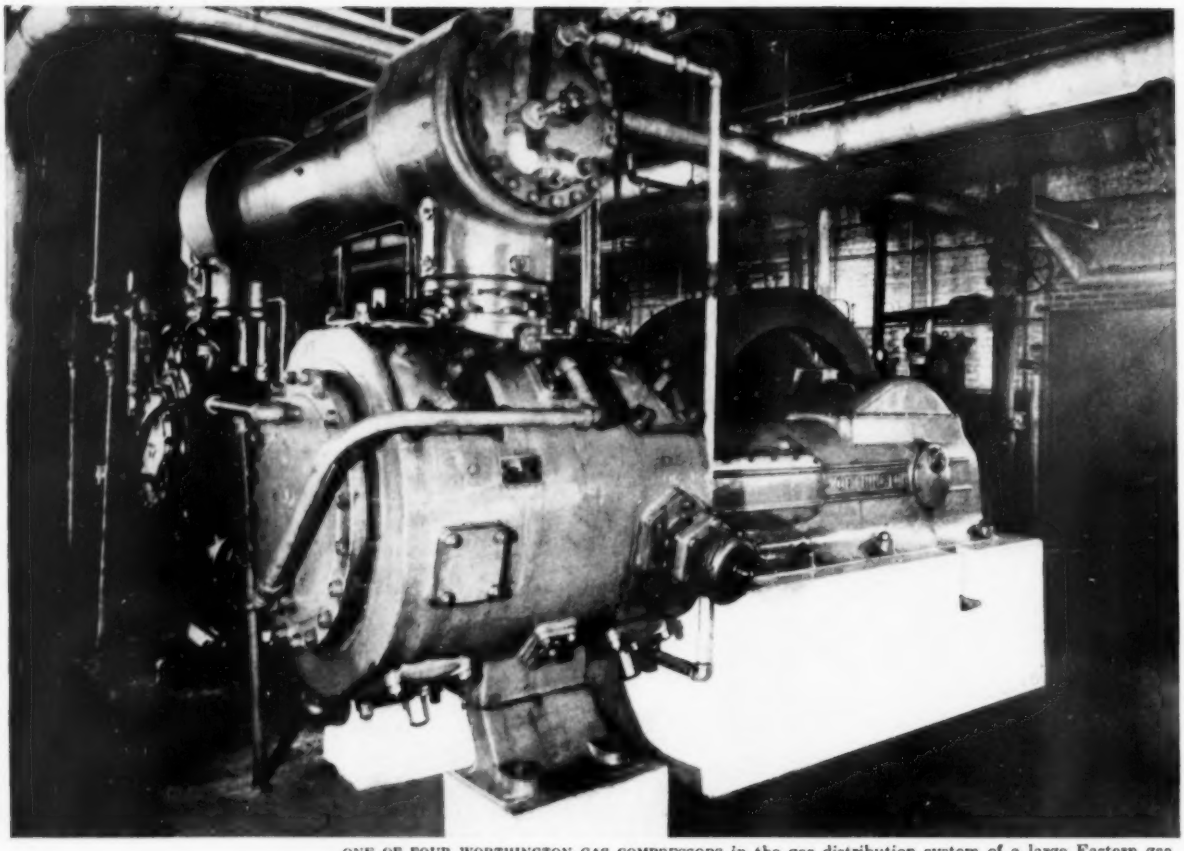

ONE OF FOUR WORTHINGTON GAS COMPRESSORS in the gas distribution system of a large Eastern gas company. Compressor is positive displacement reciprocating type with capacity of 125,000 standard cu ft of manufactured gas per hour. Maximum discharge pressure is 100 psi. Volume is controlled by Worthington's automatic variable capacity control.

When a large Eastern gas company needed another gas compressor . . .

. . . There was no question about which make should be selected!

The gas compressor in the picture had been working so well since 1949 that Worthington was the logical choice for the *next* new compressor to handle expanded capacity.

These Worthington features constantly increase the number of such choices:

Accurate control of volume that is always assured with Worthington's automatic variable capacity control — acknowledged most accurate, flexible and simple control obtainable.

Worthington's exclusive Feather Valve* — simplest, lightest, most efficient ever made — eliminates valve problems. And Worthington's high-efficiency intercooler needs less water, less power, less attention.

Somewhere in the broad line of Worthington compressors, for air, gas or other "compressables", there is the one right type and size for your job. *Worthington Corporation, Compressor Division, Buffalo, N. Y.*

*Reg. U. S. Pat. Off.

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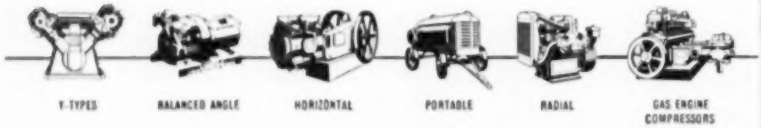

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DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

August ★ One of a Series of Interest to the Petroleum Industry ★ 1953

All dressed up . . .

IN PETROLEUM PRODUCTS!

Miss Joanne Melberg was crowned Queen of the Lakes at the Minneapolis Aquatennial Summer Festival last month.

But what, you ask, has that got to do with the petroleum business? Just this—Miss Melberg's entire wardrobe, including the nylon evening gown she is wearing in the picture above, was made of petroleum-based synthetic fibers. In addition to this nylon dress, her official Festival wardrobe contained suits, dresses, gloves, hats and a bathing suit of "Dacron" polyester fiber. And as Queen of the Festival, she is being sponsored by the Oil Industry Information Committee of the American Petroleum Institute.

This fashionable wardrobe is an excellent example of how the petroleum and chemical industries are working together to develop a world of new products that mean easier and more comfortable living for millions of people.

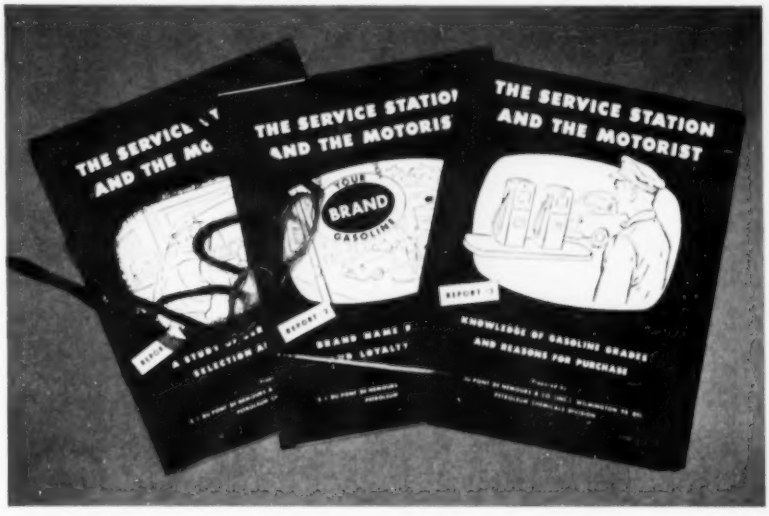
Textile fibers by Du Pont are only one example of the tremendous progress now being made in the development of petroleum-based chemical products. The complete roll call includes hundreds of products that make our work easier, our recreation more enjoyable, our homes more livable, our farms more productive, and our industries more efficient . . . products like anti-freeze, insecticides, synthetic rubber, weed killers, plastics, explosives, finishes, detergents and pharmaceuticals.

How motorists choose the *grade* of gasoline they buy

A merchandising opportunity is pointed up in Du Pont Survey Report No. 3 on Consumer Gasoline Buying Habits

Once the motorist has decided to buy *your brand* of gasoline and driven into the station, which *grade* will he choose? And what is the basis for his choice? Is it price . . . power . . . mileage . . . or the particular requirements of his car?

Findings on these questions are discussed in Report No. 3 of Du Pont's Consumer Gasoline Buying Habits Survey. It is now being distributed to refiners and marketers.



THREE REPORTS on Du Pont's continuing survey of Gasoline Buying Habits have been published so far. The first was a study of service station selection and loyalty. The second covered brand name recognition and loyalty. Future reports will deal with price and credit cards, oil and TBA purchases, and dealer services.

To get this information, 3,100 household interviews and 21,000 observations at 1,193 service stations were conducted as part of the Du Pont survey. National in scope, the survey is representative of gasoline buying patterns and trends throughout the country.

WEST PREFERS PREMIUM

In only one of the four major gasoline marketing areas of the U. S., does the preference for premium exceed that for regular. This is in the West where 55.2% of the motorists say they usually buy the premium grade. In the South the preference for the two grades is practically equal. In the Central area, a big majority prefer regular and regular has an edge over premium for the motorists' preference in the Northeast.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

CONTINUED *Survey Report*

PRICE FACTOR

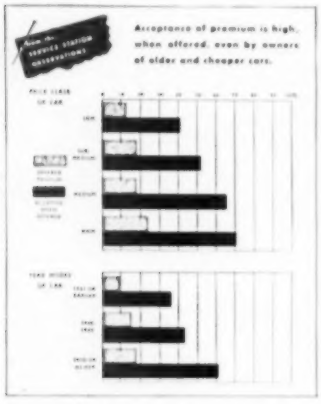
As might be expected, the customers who own more expensive cars and are in the higher income groups are the principal premium purchasers.

Among those motorists surveyed who usually buy the regular grade, 51.9% said they do so because it is *cheaper*. However, there is equal mention of performance of regular as "reason" for its selection. Many of those who usually use regular say its performance is satisfactory or equal to that of premium.

PERFORMANCE COUNTS

Among the premium users surveyed, by far the greatest majority gave reasons that added up to "performance." Of these, 56.9% specifically stated that more power, better pickup, acceleration and all-around performance were the main reasons for their choice. One-quarter said they use premium because it prevents knock. Better mileage, faster starting and high-compression engine requirements were given as reasons for choosing premium by the remainder of motorists who usually buy it.

When asked directly what they considered the *chief differences* between the two grades, the motorists surveyed supplied a wide variety of answers. Power, octane rating, starting speed, mileage and smoothness of performance were the answers most frequently encountered. Such factors as knock resistance and the addition of special ingredients received a smaller percentage of mentions.



A TYPICAL PAGE from Report No. 3 shows that customer acceptance of premium grade gasoline is high, when offered by dealer.

SALES OPPORTUNITY

One of the most interesting parts of this Du Pont Survey Report No. 3 deals with the way in which motorists ask for, or "are sold," a particular grade of gasoline. This part of the survey is based on the service station *observations*. These observations reveal what motorists and dealers *actually do* at the point of purchase, rather than what they *think* they do or *say* they do when questioned.

These observations showed that two-thirds of the premium purchasers requested it themselves. *Only one out of eight* of all the motorists observed were *offered premium*. However, *two out of three* of the motorists observed, who were offered premium, followed the suggestion of the dealer in grade selection. And even among the owners of older and cheaper cars, the acceptance of premium grade offers was high.

Information like this, we believe, can be extremely valuable to oil companies in planning their service station merchandising and promotion campaigns.

GULF COAST DISTRICT MANAGER

CHARLES D. TOWERY is manager of the Du Pont Petroleum Chemicals Division Gulf Coast District. He joined the Du Pont Company in 1947. After three years as a sales-service representative in the Petroleum Chemicals Division, he was made district manager of the Mid-Continent District and was transferred to his present assignment in 1952.

Mr. Towery brought to Du Pont a broad background in oil refining. It began with a B.S. degree in Chemical Engineering from Texas A&M in 1932. He then joined the sales department of the Gulf Oil Corporation.

In 1934 he joined the Smiths Bluff Refinery of the Pure Oil Company. For three years he worked on all phases of physical and chemical analysis–including knock test engines–at the refinery control laboratory.

He was transferred in 1937 to Pure Oil Company's operating department as a process engineer. There he gained wide experience in distillation, treating, pumping, blending, instrumentation and many other facets of oil refining. Later he was moved to the company's Chicago office and was assigned to pilot plant studies.

Mr. Towery was called by the Navy in 1942 as petroleum specialist. Following his discharge in 1945 as a Lieutenant Commander, he was associated with Bethlehem Supply Company as sales engineer in the Refinery Sales Department.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets and aids available to you through any Du Pont Petroleum Chemicals Division district office:

The Service Station and the Motorist—Report Nos. 1, 2 and 3 are now ready for distribution. Authoritative studies on gasoline buying habits in regard to service station loyalty, brand name loyalty and gasoline grade selection Serials A-5396, A-5347 and A-5826

Du Pont Fuel Oil Additive No. 2—A 12-page bulletin describing this ashless stabilizer and dispersant which prevents clogging of fuel oil screens Serial A-5201

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Pass turbulently flowing sea water containing air bubbles through a heat exchanger and you have as vicious an enemy as ever attacked a tube. This combination meets its match, however, in Ambraloy-927,* arsenical aluminum brass.

Ambraloy-927 tubes specifically resist corrosion by both salt and brackish waters under many operating conditions by quickly forming a protective surface film. This film resists the impingement of turbulently flowing sea water containing air bubbles and abrasive solids. The presence of arsenic in the alloy gives Ambraloy-927 its high resistance to dezincification.

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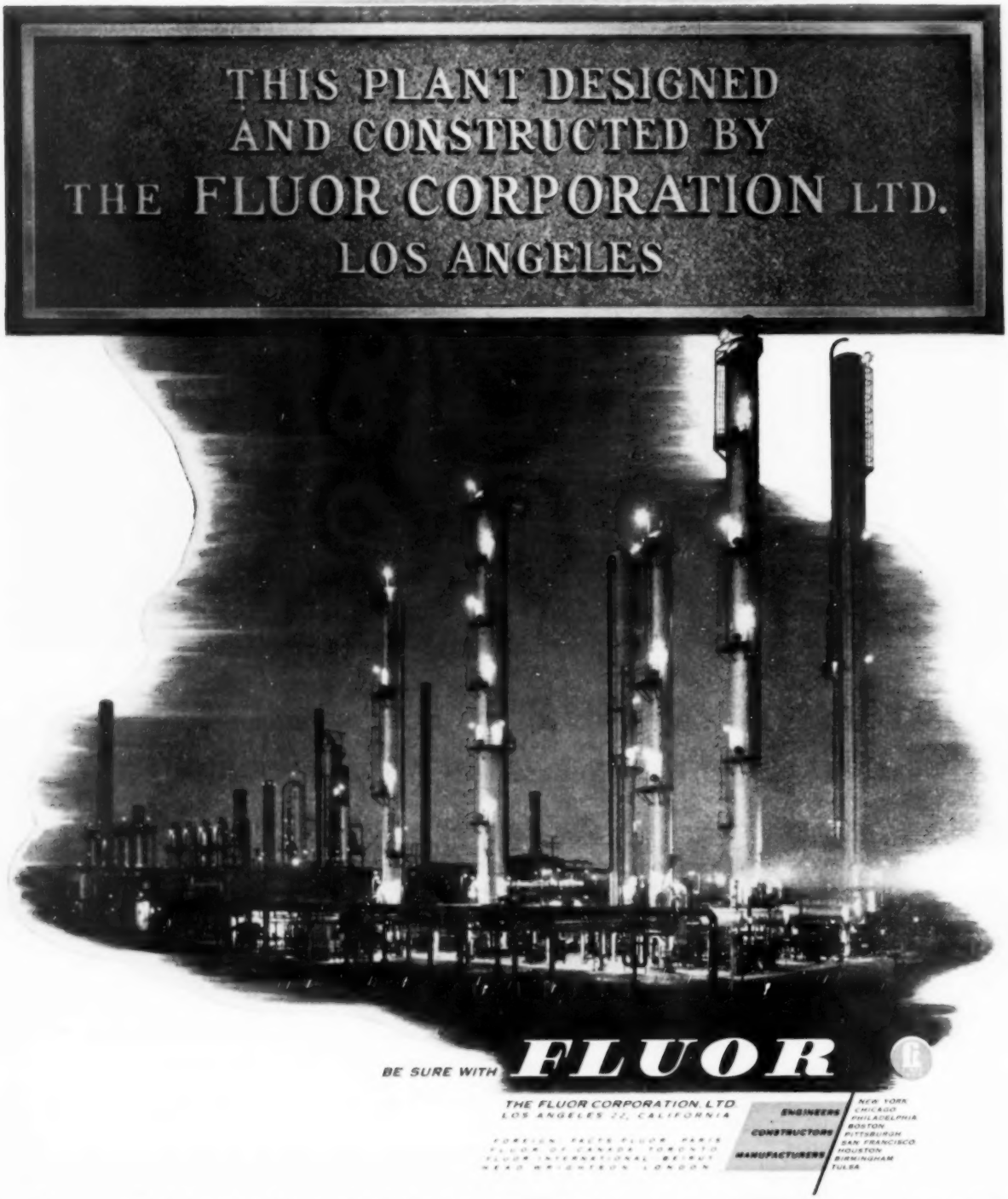
(To obtain more data on advertised products see page 1232)

EL SEGUNDO, CALIFORNIA – This plant for the preparation of feed stock for facilities used in the production of benzene and blending stocks for aviation and quality motor gasoline was designed, engineered and constructed by Fluor for Standard Oil Company of California at their El Segundo refinery. It was completed on schedule and within the budget money appropriated. Fluor has recently been awarded another contract by Standard for the engineering and construction of a 40,000 B/D (Model IV) Fluid Catalytic Cracking Unit – the largest of its kind in the world – including fractionating, gas recovery, caustic treating, hydrogen sulfide removal, additions to the alkylation unit, alterations to the naphtha re-run stills, and offsite engineering – all part of the $20 million expansion program now in progress. Whatever your plans include – a completely integrated plant or the expansion of existing facilities – Fluor's knowledge and experience to design and build for the refining and processing industries, are at your disposal.



IN 5 MODERN FABRICATING SHOPS

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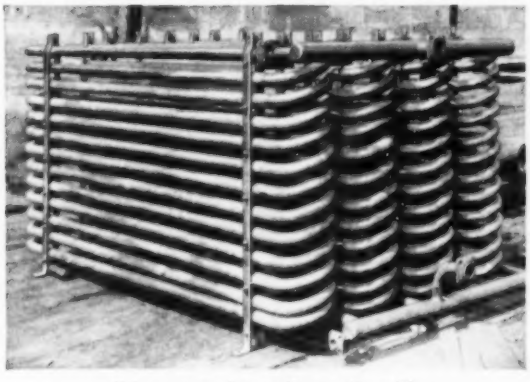
builds pipe coils to DESIGN perfection



2-in. ammonia cooling coils with welded headers and ammonia flanges.

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Although seamless carbon steel pipe is most popular, Crane has the experience—and the equipment to produce pipe coils in wrought iron, copper, brass, nickel, aluminum, 18-8 of various types, and miscellaneous alloys. At your service are the finest facilities for heat-treating, stress-relieving and testing of all kinds. Crane can also supply those necessary piping accessories to give your design the added value of consistent quality throughout.

There's further information on this important Crane service in your Crane No. 53 Catalog—and in the 48-page Pipe Coil Handbook, offered below.

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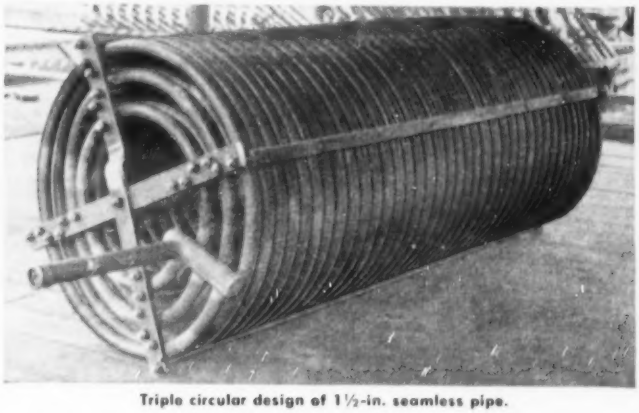
Gives Va'uable Design and Specification Data

Dimensions, materials, end connections, pipe data, helpful engineering information—you'll find it all in this factual, easy-to-read handbook, free to pipe coil designers and users. Drop a card to Crane at the address below for your copy (Circular 318).



Triple circular design of 1½-in. seamless pipe.

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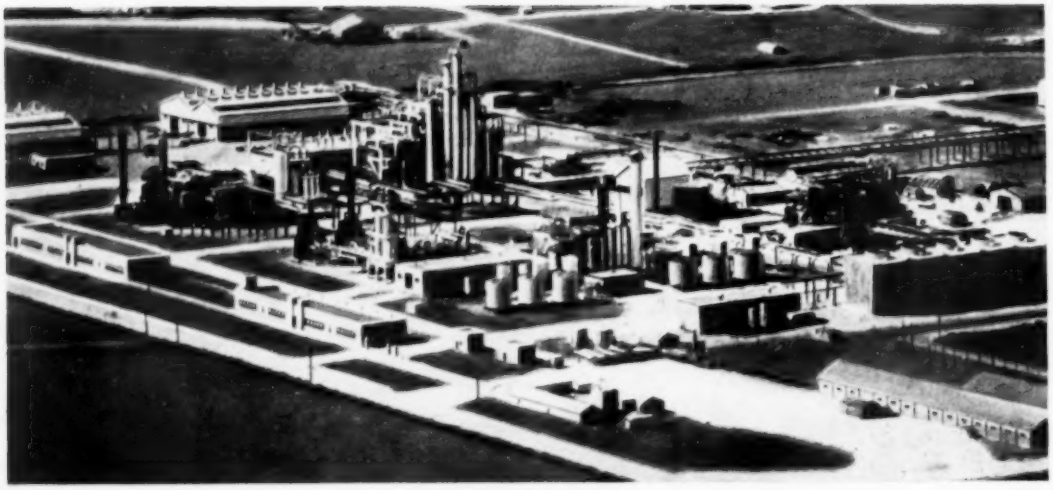

Development Studies *and* Reports

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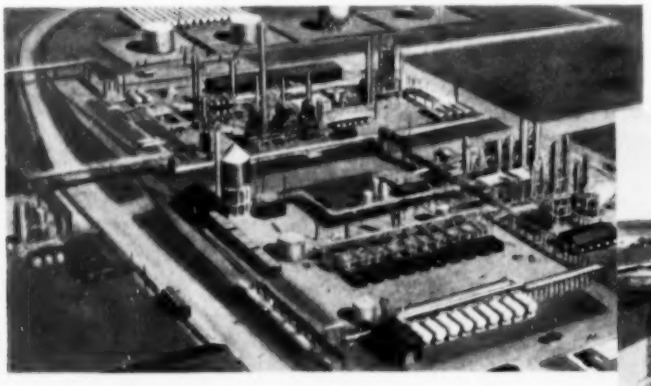

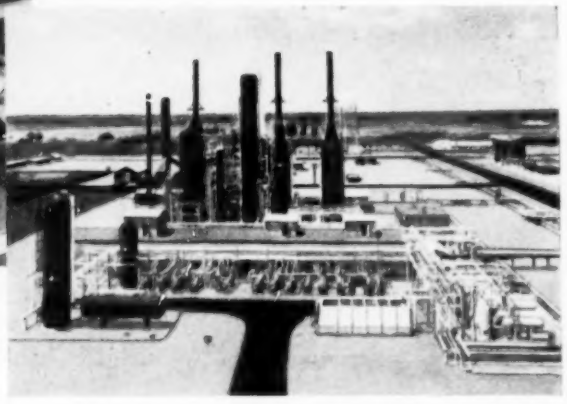

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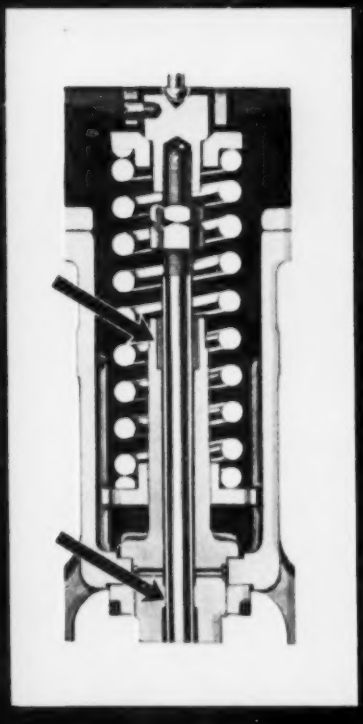

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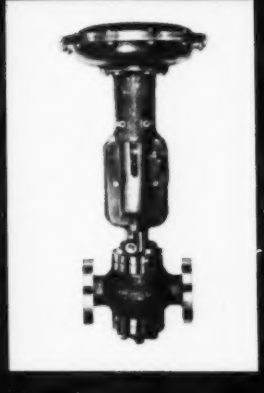

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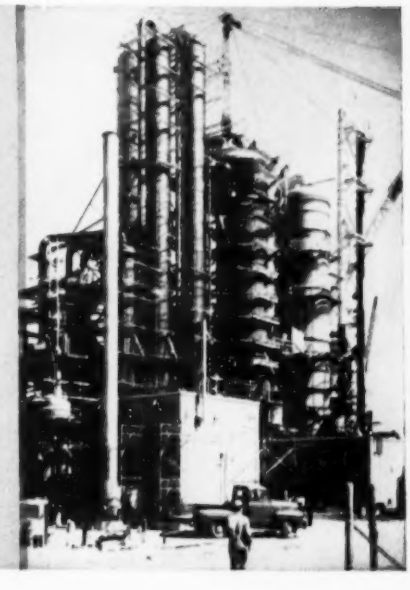

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Analysis, Tolerance and Finish are guaranteed to be "as ordered" on every shipment of Carpenter Stainless Tubing.

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(To obtain more data on advertised products see page 1232)

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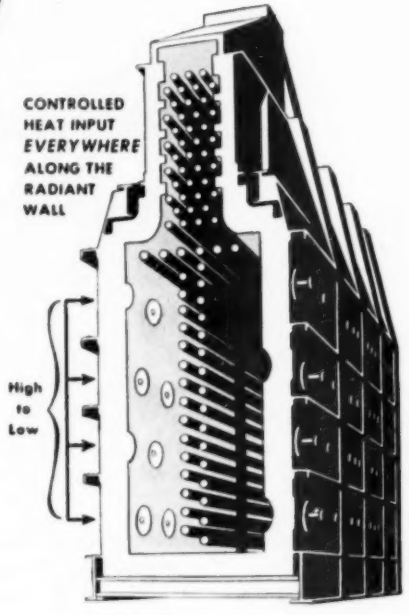

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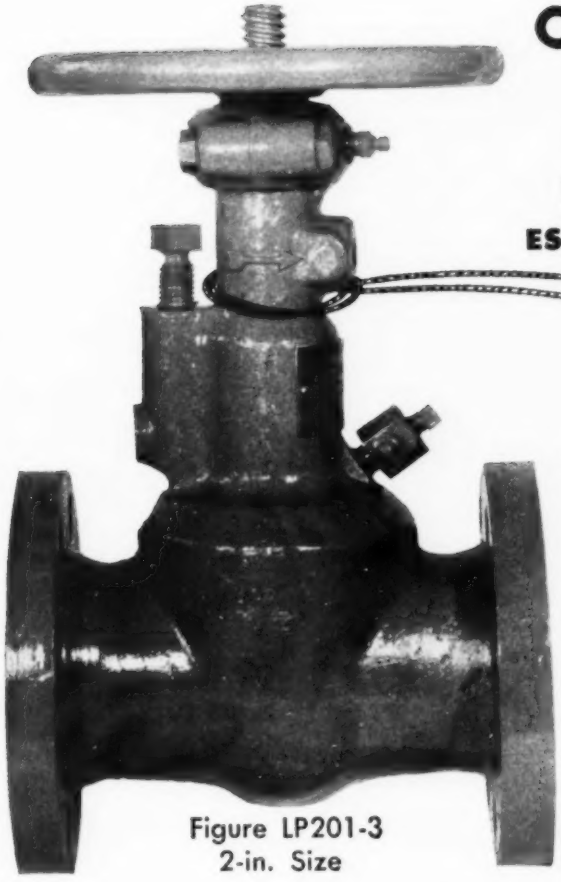

Figure LP201-3
2-in. Size

1. Forged Steel Body and Bonnet — Welded together to insure against vapor leaks.

2. Plastic Stem Packing that is adjustable. Stem Packing Chamber is backed up by a supply of auxiliary packing as extra insurance against leakage along the stem. Can be repacked under pressure in either open or closed position.

3. A Seating Principle that is both resilient and friction free, requires no lubricant to effect a seal or to wash out and contaminate the fluid being handled.

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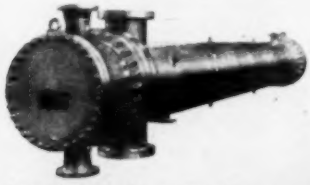
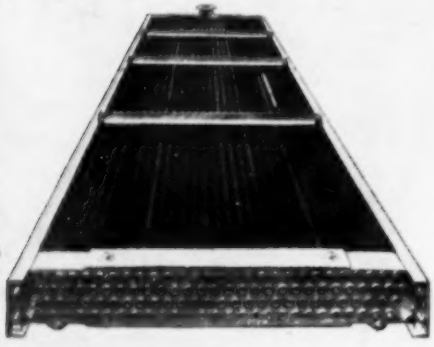
Twin G-Fin Section, used on a greater variety of heat transfer services than any other design of apparatus.

G-Fin Storage Tank Oil Heater, available in designs for installation partly within or entirely outside of tank.



G-Fin Heat Exchanger, for cooling large quantities of gases, or for cooling or heating viscous liquids.

K-Fin Tar-Heated Reboiler, for separation of liquids which do not have close distillation curves.



K-Fin Atmospheric Section, used in the Fin-Fan Air-Cooled Exchanger, many hundreds of which are in use all over the world.

K-Fin Air and Gas Cooler and Heater, widely used to cool air or hydrogen from generator windings.

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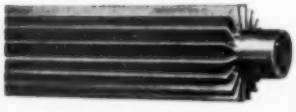
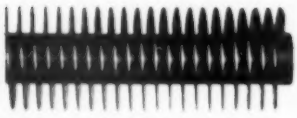


G-Fin Element with longitudinal fins



K-Fin Element with helical fins

More than 30 years ago, G-R originated the first finned heat exchanger element that would withstand high temperatures and pressures.

G-R has, since then, developed many additional designs of finned elements and many different types of finned tube units, each for a specific range of services.

Today, the G-R line of finned-tube apparatus covers every heat transfer duty in the petro-chemical industries. These units include vapor condensers, heaters, coolers, and heat exchangers . . . for light, heavy, viscous and dirty liquids, vapors and gases . . . for small and large capacities at low and high temperatures and pressures.

The operating records of the many tens of thousands of installed G-R finned tube apparatus have proved the superior effectiveness, reliability, durability and economy of maintenance of these units. Whatever your heat transfer needs may be, be sure to ask G-R for recommendations.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

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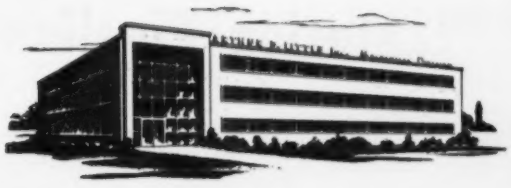

New ADL Mechanical Division Building

. . . using advanced engineering techniques

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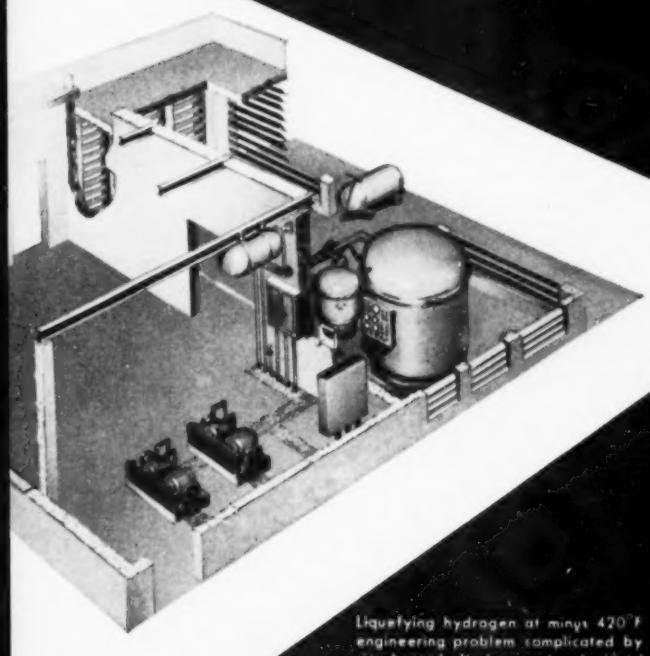
Arthur D. Little, Inc., has blended its scientific and engineering skills in the Mechanical Division to provide industry with a unique service . . . prototype development of equipment requiring a high level of engineering. Scientists in the fields of chemistry, physics, metallurgy, mathematics, biology, electronics and technical economics can be called on as required.

Our staff is experienced in interpreting the ideas of industry and following through with the perfection of specialized equipment.



Liquefying hydrogen at minus 420° F. is a formidable engineering problem complicated by possible explosion hazards. It also requires looking beyond the problem of liquefaction into purifiers, storage, and means of transport. That is why ADL's Mechanical Division completed the **whole** job of building this hydrogen liquefying plant . . . because it can draw upon engineers, physicists, chemists, and metallurgists from the staff of one of the most diversified research and technical consulting companies to assure such successful prototype development.

THERMODYNAMICS · HEAT TRANSFER · REFRIGERATION TO MINUS 456 F · VACUUM ENGINEERING · GAS LIQUEFACTION · ELECTROMAGNETISM · MECHANICAL DESIGN · VIBRATION

Write for Brochure PP20-1

MECHANICAL DIVISION

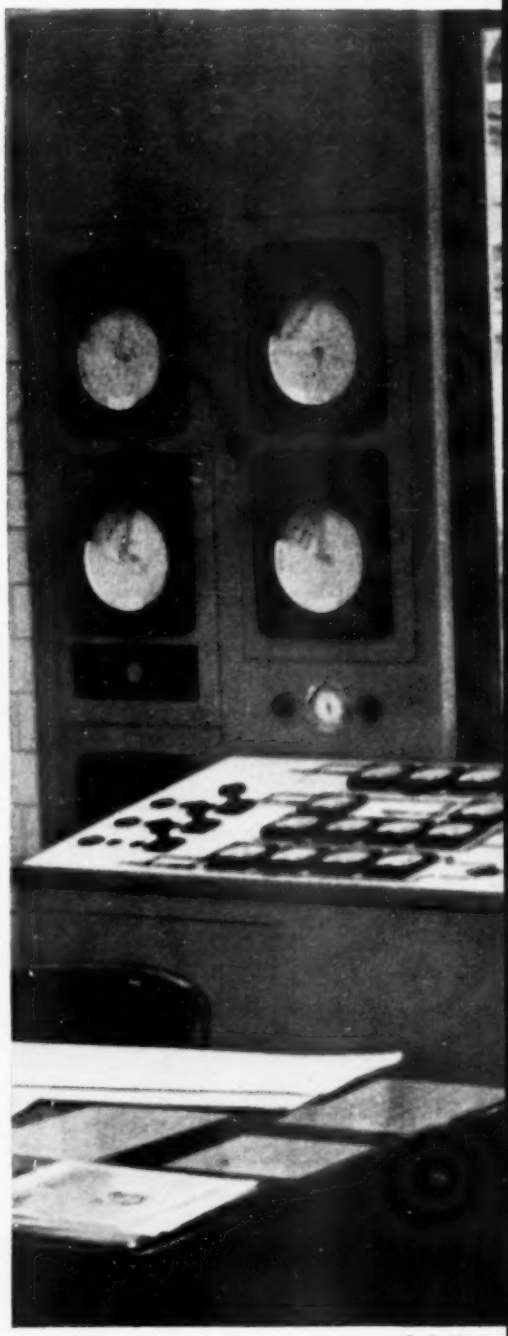
Arthur D. Little, Inc.

CREATIVE TECHNOLOGY SINCE 1886

ADL Mechanical Division

30 MEMORIAL DRIVE, CAMBRIDGE 42, MASS.

Here's how Power System Planning pays off for Plantation Pipeline



When Plantation's line was first built in 1941, Westinghouse worked with them in planning the electrical control system. So many of the ideas paid off in lower maintenance, system flexibility and reduced power costs that the new expansion program incorporates many of these ideas along with some new ones developed between our engineers and theirs. Here are a few of the outstanding features.

Use little more power despite doubled capacity

The new parallel line doubles system capacity but power requirements have increased only slightly. One important way this was done was by preventing extra charges for peak power loads. When the load reaches the upper limit, a flow-control valve automatically cuts it back.

Highly mechanized system

Another feature was the use of automatic controls wherever possible. As a result, the big expansion increased man power needs very little. For example, if abnormally high pressures or temperatures should develop, special equipment automatically shuts down the pumps or sounds a warning.

Radically new instrumentation system

Westinghouse engineers also helped develop a new instrumentation system for the pumping stations. This system using electrical strain gauges permits the use of standard electrical instruments to show pressure. This eliminates the disadvantages of pressure tubing, with its hazards of high-pressure leaks. It also simplifies instrument mounting and permits a simplified compact control board for system operation. These instruments are also more accurate than conventional gauges.

Call Westinghouse early on YOUR next project

This is a good example of the kind of thinking we can apply to *all* petroleum industry projects. When your next job comes up, call in Westinghouse early. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Penna.

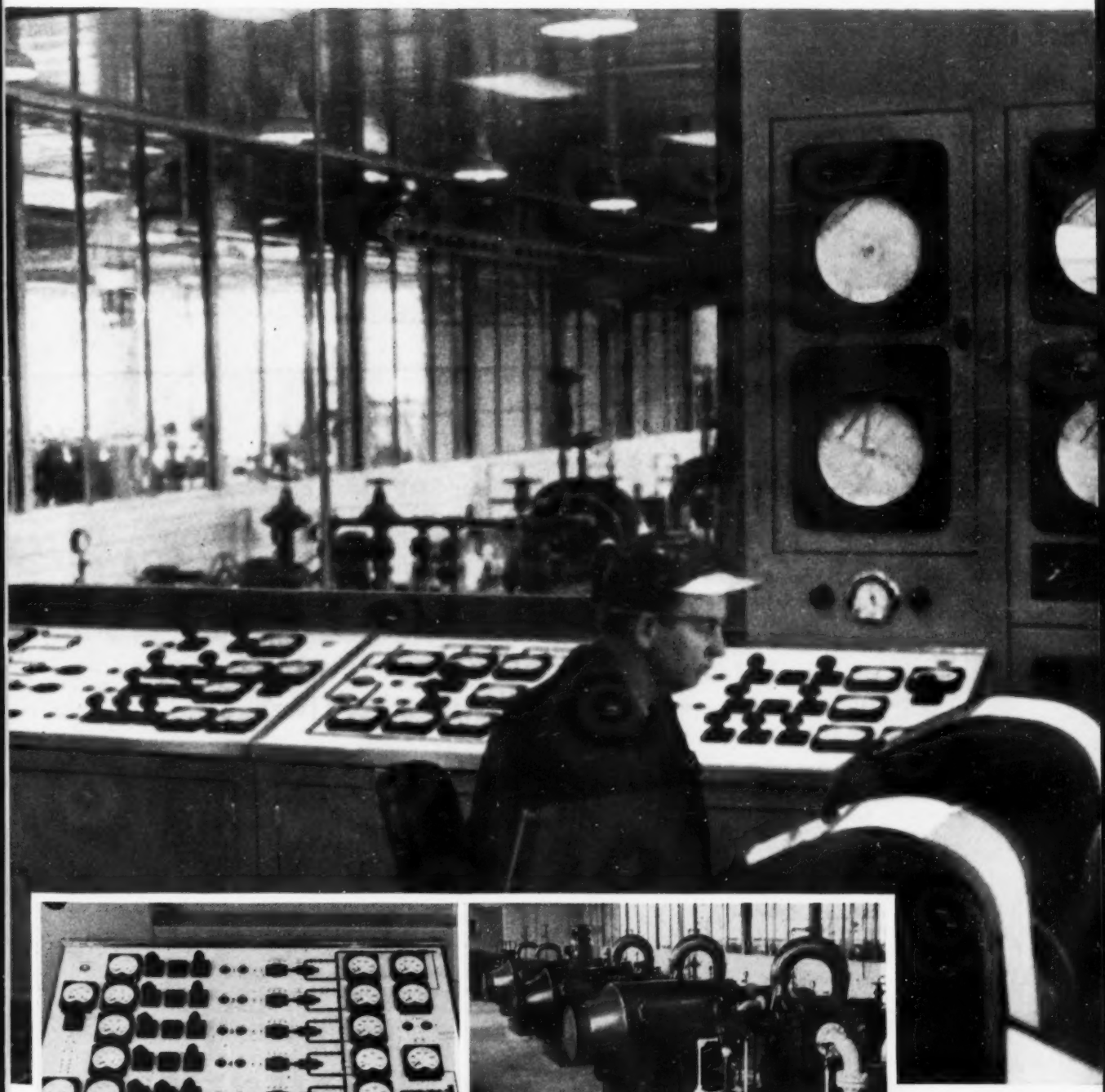
J-94907

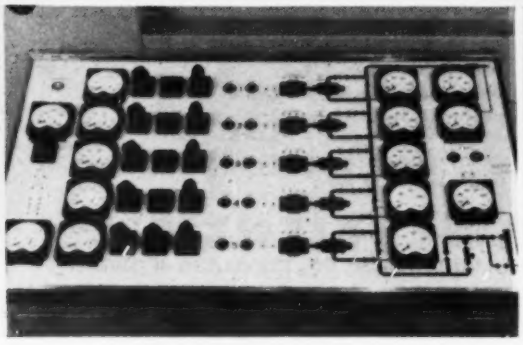
YOU CAN BE SURE...IF IT'S

Westinghouse

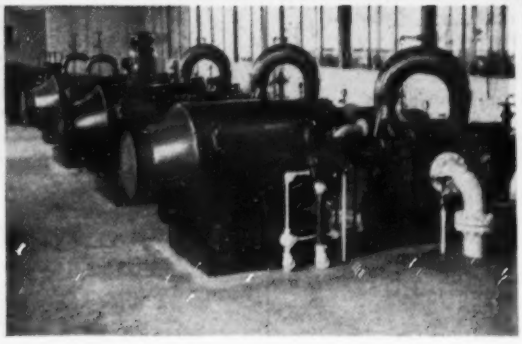
EQUIPMENT FOR THE PETROLEUM INDUSTRY

They did what you can do to produce more





Plantation's highly mechanized pumping stations are operated from these Westinghouse control panels. Electrical pressure gauges were specially developed to permit the use of the simplified flow-control board.



Big explosion-resistant Westinghouse motors drive the pumps on the Plantation Pipeline. These motors were especially designed and built for pipeline duty and they have given outstanding service.

Color Coded
HARSHAW CHART OF THE ISOTOPES*

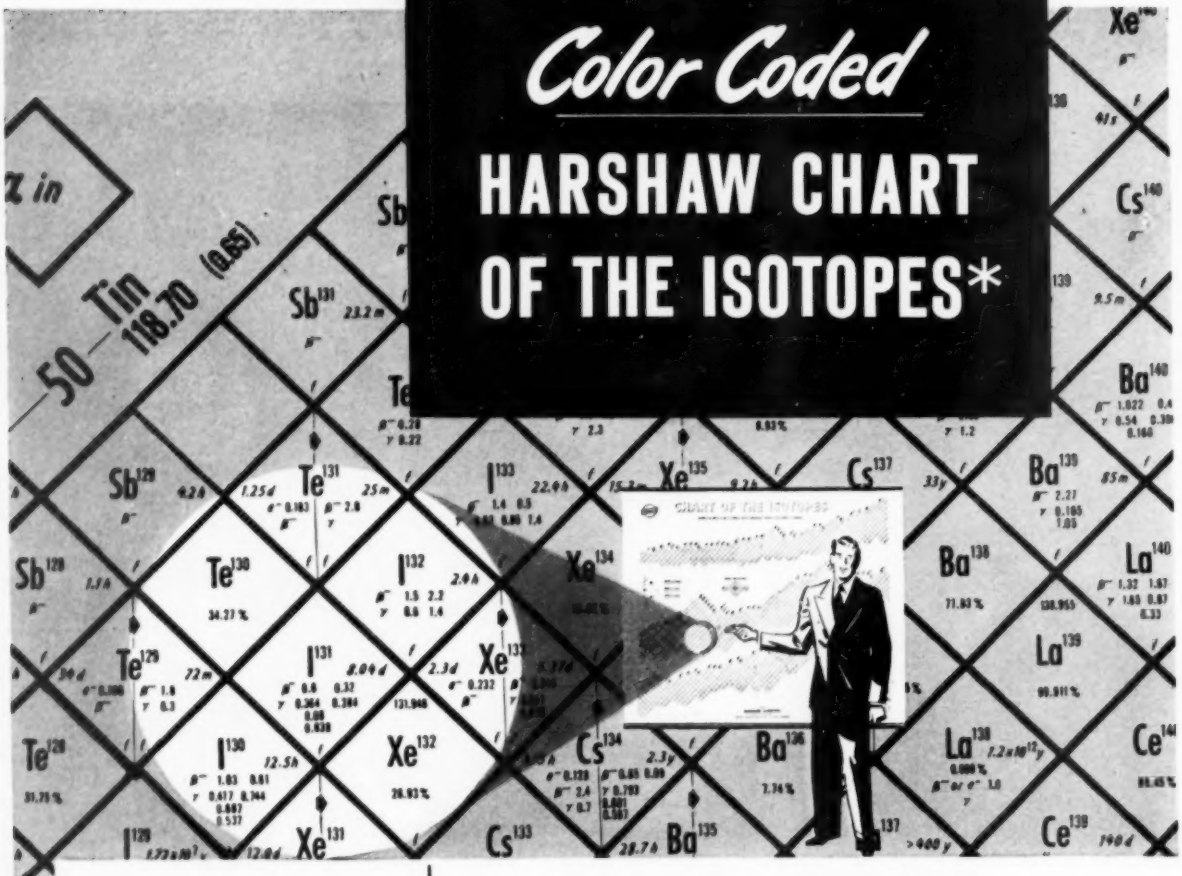


Chart Features

- **Element Name**
- **Atomic Number**
- **Atomic Weight, 1952 Revision**
- **Atomic Mass Data**
- **Thermal Neutron Cross Section**
- **Element Symbol**
- **Stable Isotopes Color Coded in Blue**
- **Naturally Radioactive Isotopes Color Coded in Green**
- **Artificially Radioactive Isotopes Coded by Half-life in 6 Colors**
- **Radioisotope half-life**
- **Modes of Radioactive Decay**
- **Radiation Energies in Million electron volts**
- **Isomeric States**
- **Isomeric Transitions**
- **Nuclear Transmutation Code**
- **Percentage Abundance of Naturally Occurring Isotopes**
- **Fission Data (thermal fission of U^{235})**
- **Lithographed in 8 Colors Plus Black and Gray**
- ***Corrected to February 1, 1953***

Compiled and Edited by
JOHN R. BRADFORD, Ph. D.
Director Radioisotopes Laboratory,
Case Institute of Technology

*International copyright

8 Code Colors Identify Isotopes and Half Lives

The Harshaw CHART OF THE ISOTOPES is arranged to make available, in an easy to use form, all the useful information about isotopes. This new and unusual chart is designed and lithographed in ten colors to make possible rapid identification of isotope half-life and nuclear stability.

The CHART OF THE ISOTOPES is 60 by 48 inches with metal edges for hanging. Printed on Texoprint, a new plastic impregnated fibre paper developed for navy charts, it is washable, non-creasing and extremely tear resistant. The guide book sent with each chart outlines instructions for reading the chart, and summarizes many chart applications.

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DIVISION OF THE HARSHAW CHEMICAL CO., CLEVELAND 4, OHIO

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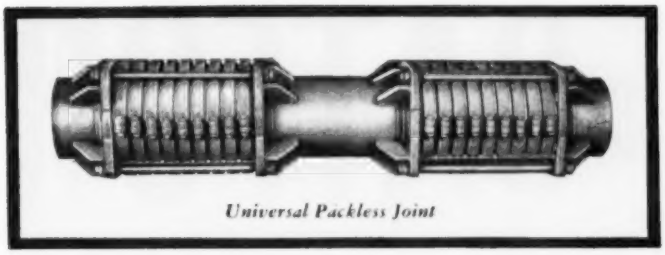
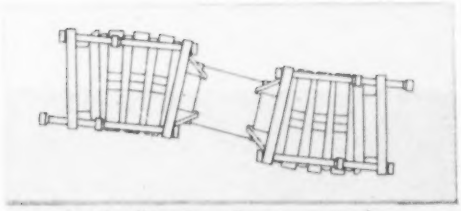


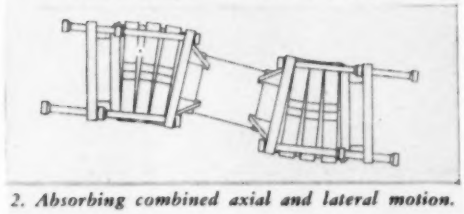
Universal Packless Joint

ADSCO Joint

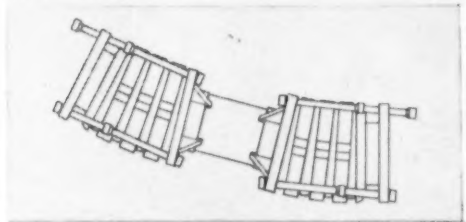
...THE UNIVERSAL FAVORITE



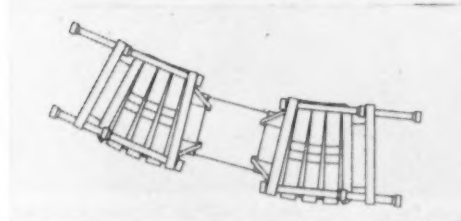
1. Absorbing lateral movement only.



2. Absorbing combined axial and lateral motion.



3. Angular rotation without axial motion.

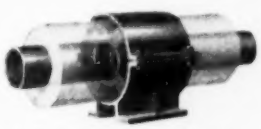


4. Combined angular and axial motion.

● When it comes to expansion joints, ADSCO is the universal favorite because ADSCO — and only ADSCO — makes a complete line of joints, both slip and packless.

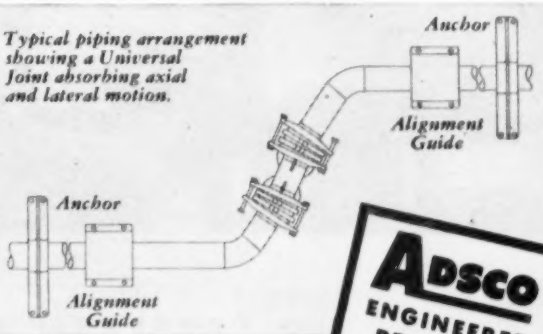
And if your problem is to absorb pipe line movement in all planes simultaneously, ADSCO Universal Packless Joints are the favorite . . . Often it is impossible or impractical to eliminate lateral motion or to isolate lateral from axial motion by anchors and guides. In these circumstances, the Universal Joint will reduce the number of anchors required and consequently reduce the amount of steel work necessary to support them. In Drawing 1 at the left, the Universal Joint is shown absorbing lateral movement only. By lengthening the intermediate pipe nipple the amount of lateral movement can be increased without increasing the number of corrugations. In Drawing 2, the same joint is absorbing combined axial and lateral motion. Drawing 3 illustrates the joint in angular rotation without axial motion. Drawing 4 shows combined angular and axial motion.

ADSCO can solve *any* of your pipe expansion problems. Call your ADSCO representative or write for Bulletin 35-51A.



● *For best results, use ADSCO Pipe Alignment Guides.*

● *Typical piping arrangement showing a Universal Joint absorbing axial and lateral motion.*



ADSCO ENGINEERED PRODUCTS

EXPANSION JOINTS • HEAT EXCHANGERS • STEAM TRAPS • STRAINERS • SEPARATORS • METERS

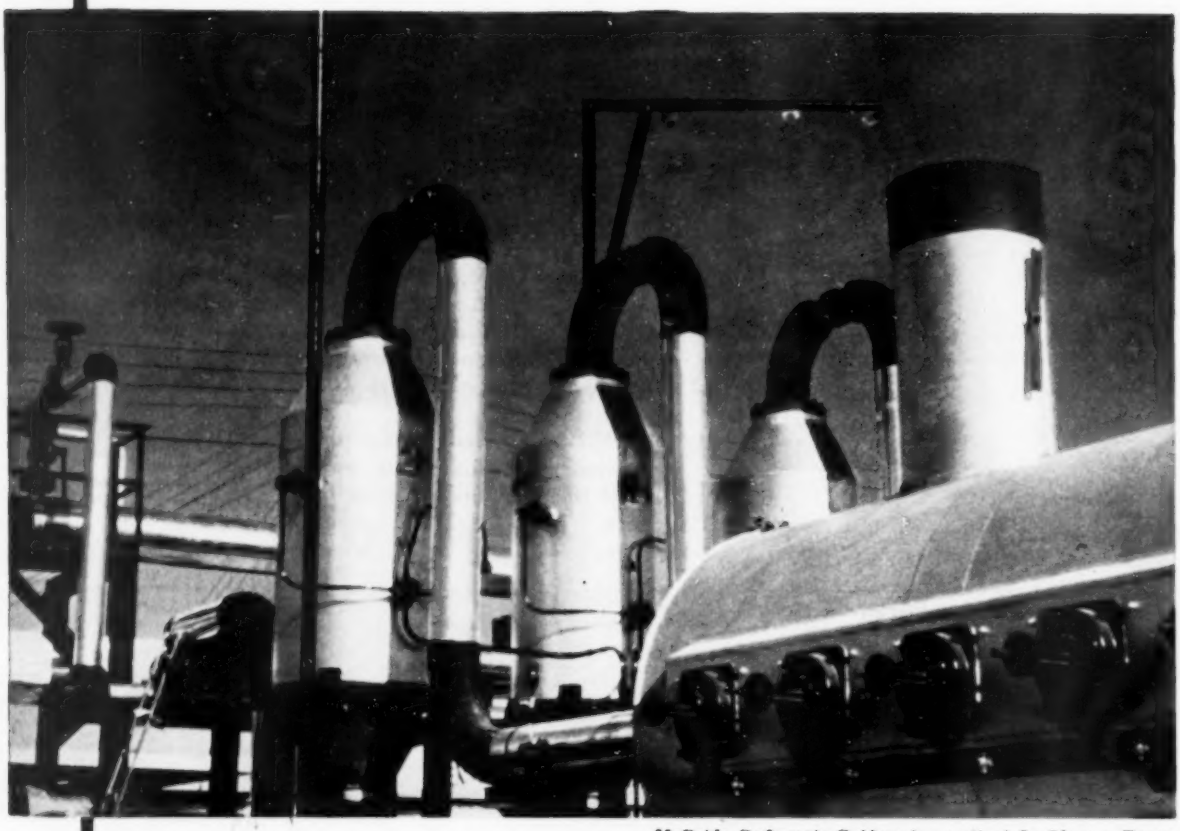
AMERICAN DISTRICT STEAM COMPANY, INC.

NORTH TONAWANDA, NEW YORK

Since 1877

(To obtain more data on advertised products see page 1232)

CATFORMING EXCEEDS ALL



McBride Refinery's Catforming unit at La Blanca, Texas

IN CATALYTIC REFORMING

IT'S THE CATALYST

(To obtain more data on advertised products see page 1232)

PLANT GUARANTEES!

McBride Catformer completes initial run. Here are the startling results:

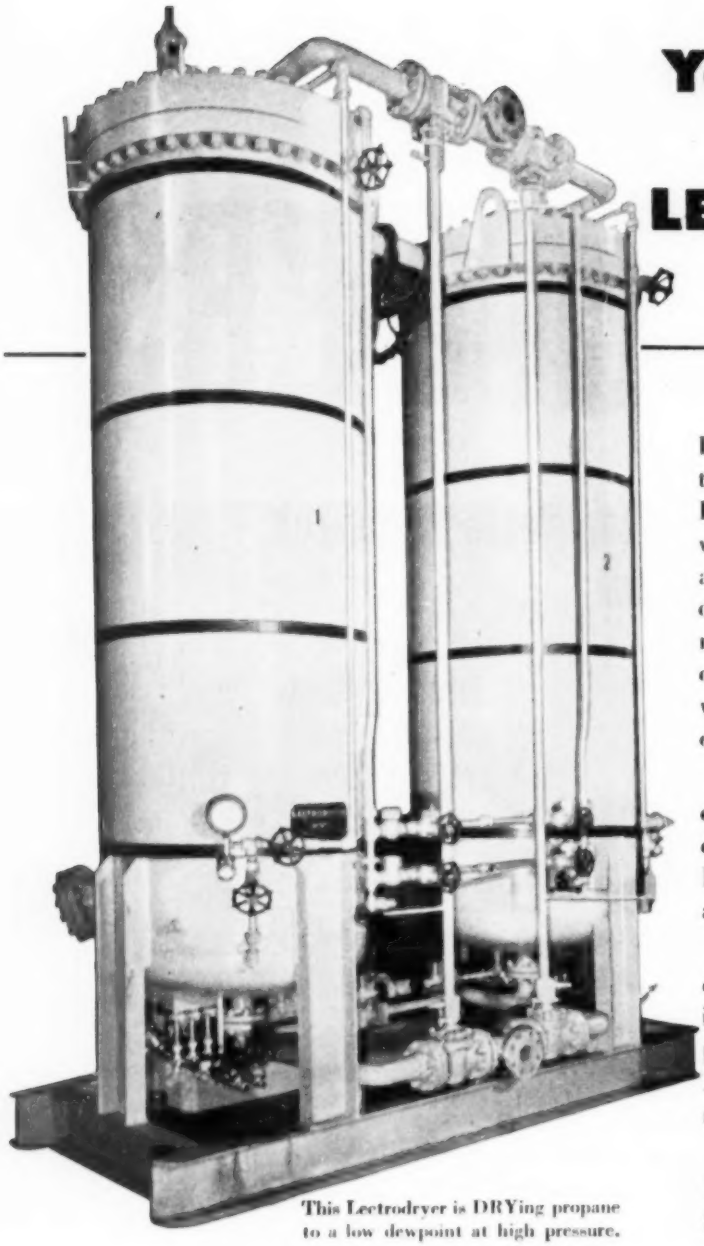
- In its initial run, all guarantees—including throughput, catalyst life, and yield octane—were exceeded.
- Starting with a 30 octane, C4 to 400° F. end point naphtha, the McBride-reformed gasoline has met final gasoline specifications throughout its entire running.
- No expensive feed preparation or product treating is required.
- The ability to regenerate the catalyst in place has been successfully demonstrated at McBride.

DO YOU HAVE YOUR COPY?

This complete bulletin tells the whole story about Catforming. Make sure you get your copy. Write The Atlantic Refining Company, Research and Development Department, P. O. Box 8138, Phila. 1, Pa. (Telephone HOward 5-2345.)

THAT COUNTS

ATLANTIC



This Lectrodryer is DRYing propane to a low dewpoint at high pressure.

You pay so little for LECTRODRYER'S experience

Lectrodryer engineers are veterans at this DRYing business. They started DRYing air, gases and organic liquids when a processor had to design, build and gamble on the effectiveness of his own drier. Today the knowledge our men have gained throughout the years, on jobs in every industry all over the world, is at your command without extra cost.

No need for you to have the bother, extra expense and delay which so often develop in building a new product. Lectrodryers are as standard as motors; a type and size for every service.

Let Lectrodryer advise you on a dryer when the job is still on the drawing board. You may save at several points by using standard equipment. And, when the Lectrodryer gets on stream, you know it's going to work.

For DRYing help, write Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Pennsylvania.

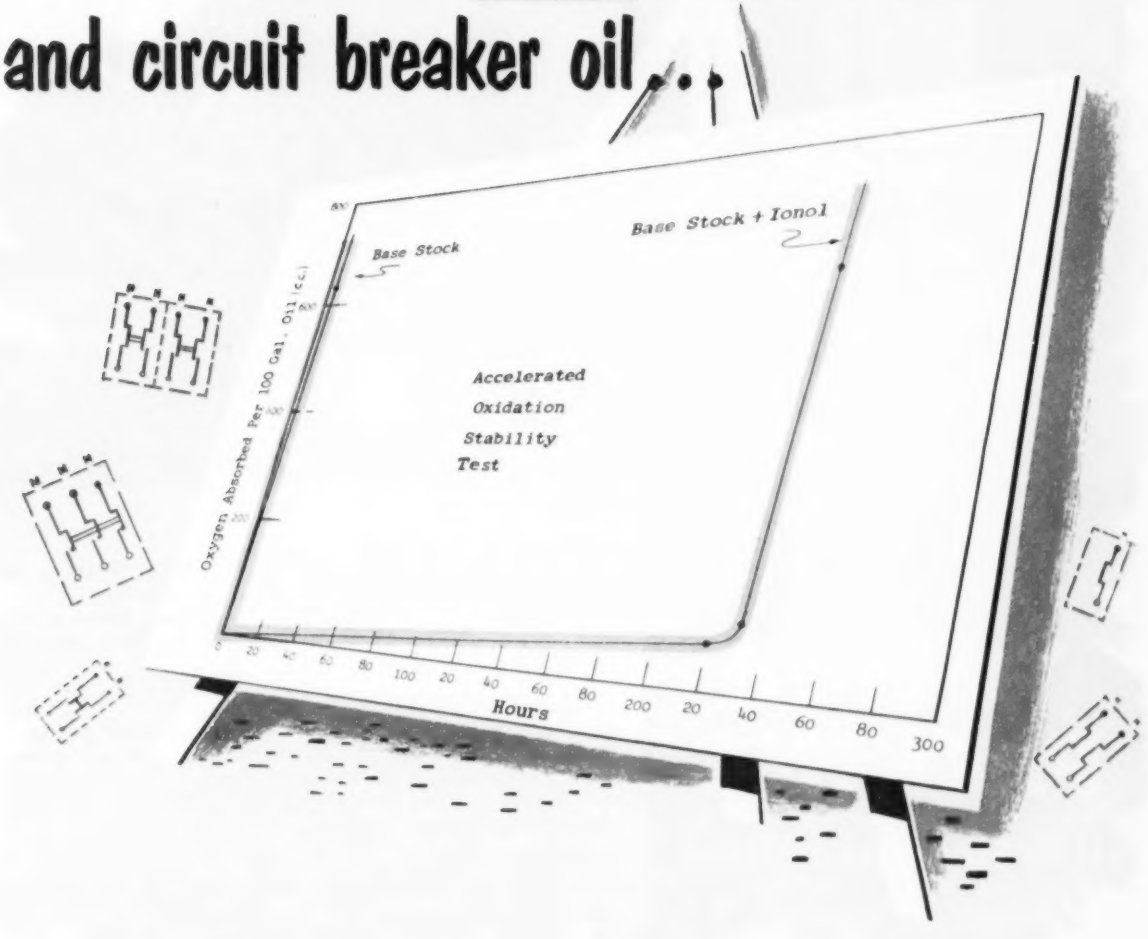
In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U. S. PAT. OFF.

How to make a better transformer and circuit breaker oil...



In electrical insulating oils, as with most others, oxidation reduces efficiency and seriously shortens service life.

Peroxides attack cotton insulation on conductors. *Sludge* lowers cooling efficiency. *Acidity* encourages carbon-moisture suspensions which adversely affect dielectric properties. All of these undesirables are by-products of oxidation.

The inclusion of a single anti-oxidant additive—Ionol—in very small amounts, endows an insulating oil with a *three to five* times longer life of trouble-free operation than identical uninhibited oils. And Ionol is stable to color change in both use and storage.

Ionol has a long record of success as an anti-oxidant in gasolines and lubricating oils. A brief study will convince you that Ionol is the logical inhibitor for insulating oils . . . and that it is logical indeed to use an inhibitor when your goal is a better insulating oil!

IONOL®

the anti-oxidant additive

You are invited to write for the Shell Technical Bulletin, *Ionol as an Anti-oxidant in Insulating Oils.*

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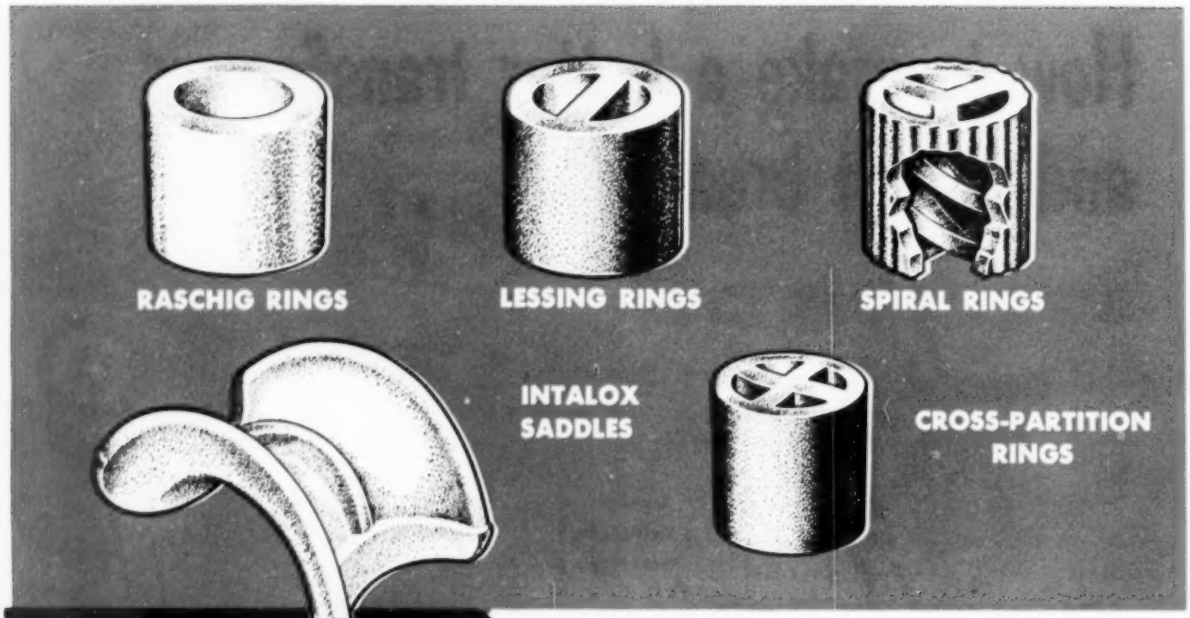


TOWER PACKING

U. S. Stoneware offers a range of types and sizes of Tower Packings not even remotely approached by any other manufacturer . . .

INTALOX SADDLES
Unique design minimizes "pattern" packing, blocking, or nesting in dumped beds. Appreciably greater surface area. Lower pressure drop. Higher flooding limits. Made in ½" ¼", 1", 1½" and 2" sizes in both high-fired chemical porcelain and chemical stoneware.

RASCHIG RINGS
Low initial cost. Most widely used of all tower packings. Made in chemical porcelain, chemical stoneware, carbon, steel and other alloys. Size range from ¼" to as high as 6", depending upon material. Sizes up to 2" are generally dumped. Larger sizes, stacked.

LESSING RINGS
A modification of the Raschig Ring. The ring has a single partition or web added to the inside. Made in 1", 1¼", 1½" and 2" sizes in chemical porcelain or chemical stoneware. Usually dumped.

CROSS-PARTITION RINGS
A further modification of the Raschig Ring. Two inside webs cross each other at right angles to create a "4-cell" ring. Cross-Partition rings are made in 3", 4" and 6" sizes in chemical stoneware. They are usually stacked in the tower.

SPIRAL RINGS
Made in single, double or triple spiral types. The function of the spirals is to increase the turbulence of the gas stream. Made in chemical stoneware in 3¼", 4" and 6" sizes. Spiral rings are used in stacked beds.

All U. S. Stoneware ceramic tower packings are made from bodies especially developed for tower service. They are extremely tough, possess high resistance to spalling and exceptional corrosion-resistant properties. Chemical porcelain bodies are completely iron-free and are of zero porosity.

C/11-D

The U. S. STONEWARE Co.
AKRON 9, OHIO

(*To obtain more data on advertised products see page* 1232)

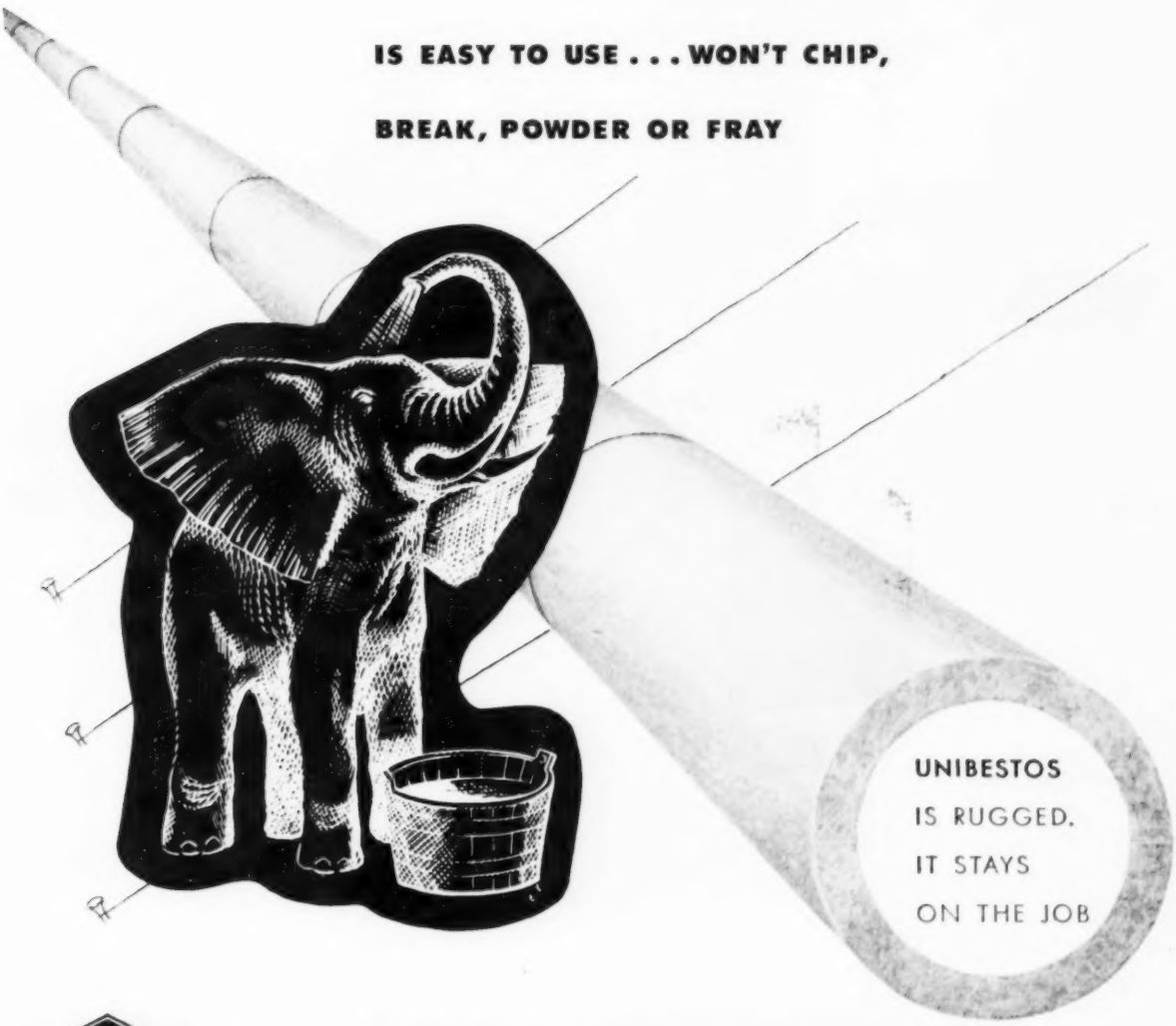
Quick and **clean** to apply

UNIBESTOS®

PIPE INSULATION

IS EASY TO USE . . . WON'T CHIP,

BREAK, POWDER OR FRAY



UNARCO **UNION ASBESTOS & RUBBER COMPANY**

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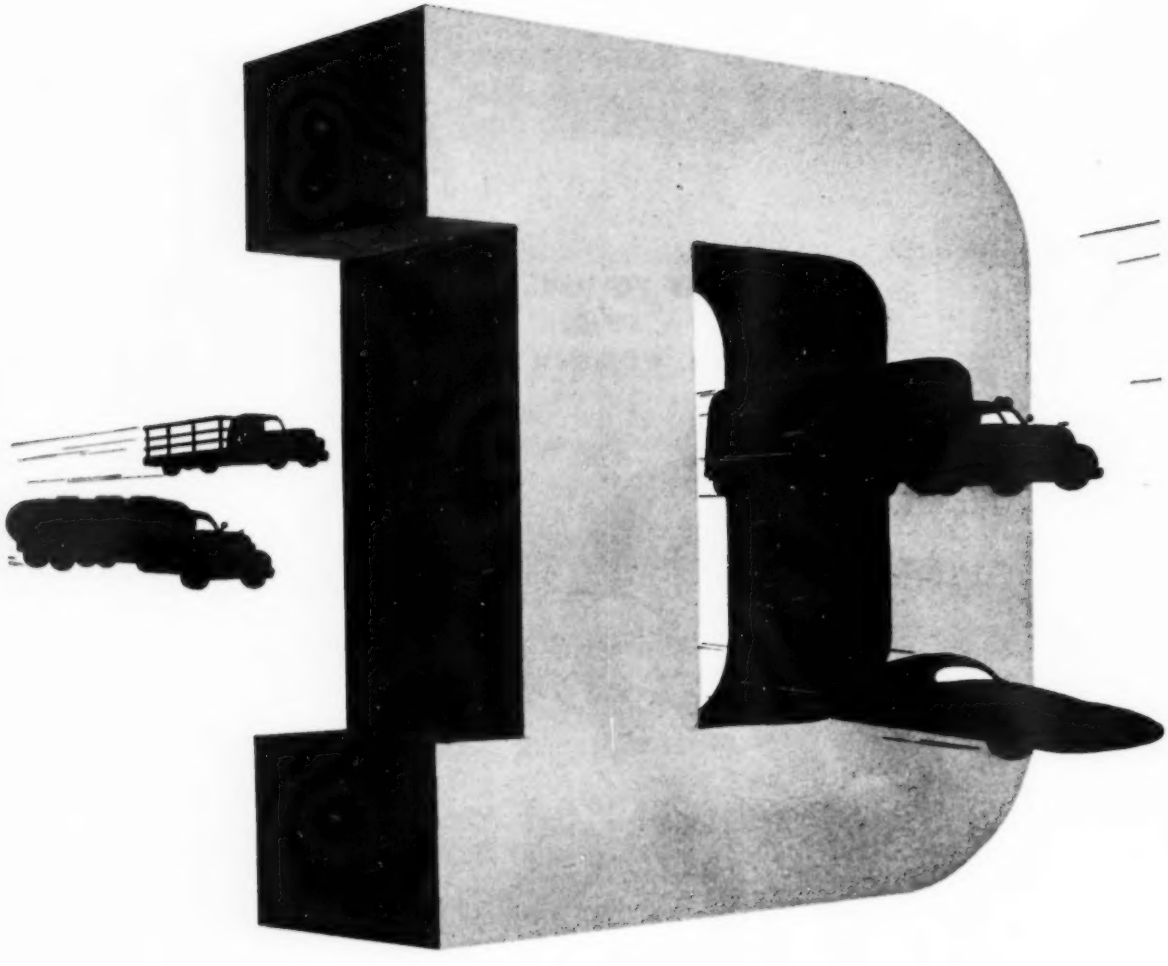

DAVISON DEPENDABLE CATALYSTS BUILD BETTER MOTOR FUEL

The operating efficiency of synthetic fluid-type cracking catalysts is important. This operating efficiency can be assured by uniformity of physical characteristics and chemical purity. Davison's production of microspheroidal (M-S*) is tops in uniformity . . . providing all users with a highly efficient synthetic fluid-type cracking catalyst. Your requirements can also be supplied in ground (DA-1*) form. Write for further descriptive information. Experienced Davison Field Service Engineers backed up with complete laboratory testing facilities are part of Davison's service.

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PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

RINGS. *Sizes:* From 3/32" I.D. x 3/16" long x 7/32" O.D. to ½" I.D. x 1" long x 1" O.D.

PELLETS. *Sizes:* From ⅛" x ⅛" to ½" x ½".

SPHERES. *Diameters:* ¼" to 1".

Rx for shorter contact time!

Norton specially engineered carriers bring proved advantages to a wide range of processes

Whatever your specific application may be, it will pay you to investigate the many advantages of Norton catalyst carriers.

Made of ALUNDUM* (fused alpha alumina), these highly refractory carriers are outstanding for heat conductivity, chemical inertness, mechanical strength and abrasion-resistance. And Norton's exclusive *controlled structure* process offers you a choice of porosities. In pellets and rings, porosities range from medium to high. In spheres, porosities range from medium, with rough exterior for coating with catalyst... to high, with a network of open pores and rough exterior for impregnating with catalyst.

Chemical engineers are finding this Norton "Special Refractory Prescription" invaluable in processing many different products. For example, in meeting the rapidly growing demand for phthalic anhydride, Norton catalyst carriers aid in shortening catalyst contact time and in achieving the highly exothermic reaction in fixed bed converters.

Test Them Out

Find out just what Norton ALUNDUM catalyst carriers can do for you. See your Norton Representative for samples, or write to NORTON COMPANY, 267 New Bond Street, Worcester 6, Mass.

Canadian Representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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REFINERY, CLEVELAND, OKLA.
LUBRICATING PLANT
CHICAGO HEIGHTS, ILLINOIS

June 11, 1953

Universal Oil Products Company
30 East Algonquin Road
Des Plaines, Illinois

Attention: Harvey Blankenship

Dear Harvey,

This month, we will reach several milestones in the operation of our Platformer. The date of June 21st, will be the second anniversary of our operations. We are still operating on the original catalyst charge and we have reason to think that it will last some longer. Our operations indicate that we are now making more light ends and that we are getting more hydro-cracking than on past performance but our yields have remained about the same throughout our entire operation.

On June 21st, our anniversary, we will have reached a thru-put of about 1,050,000 barrels and a true platformate production of 971,250 barrels. We will have charged 160 barrels of reactor charge for each lb. of initial catalyst, at a catalyst cost of less than 2.5¢ per barrel.

During the 2 years of operation, we have been down 25 days due to strike and 17 days for inspection, minor repairs and changes. We thought that this information might be of interest and value to you.

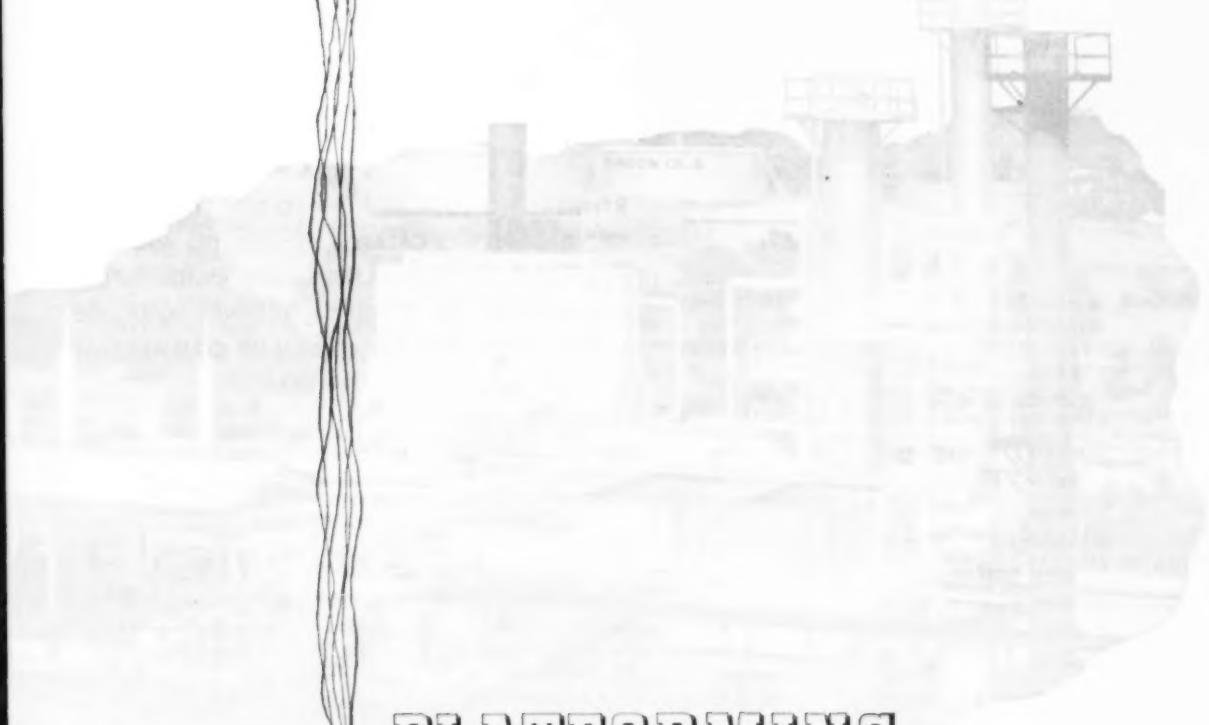
Sincerely yours,

W. J. Leenhouts
Refinery Manager

WJL/ds

YES, MR. LEENHOUTS . . .

THIS IS VALUABLE INFORMATION TO EVERY PETROLEUM REFINER



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UNIVERSAL OIL PRODUCTS COMPANY

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Laboratories: RIVERSIDE, ILLINOIS

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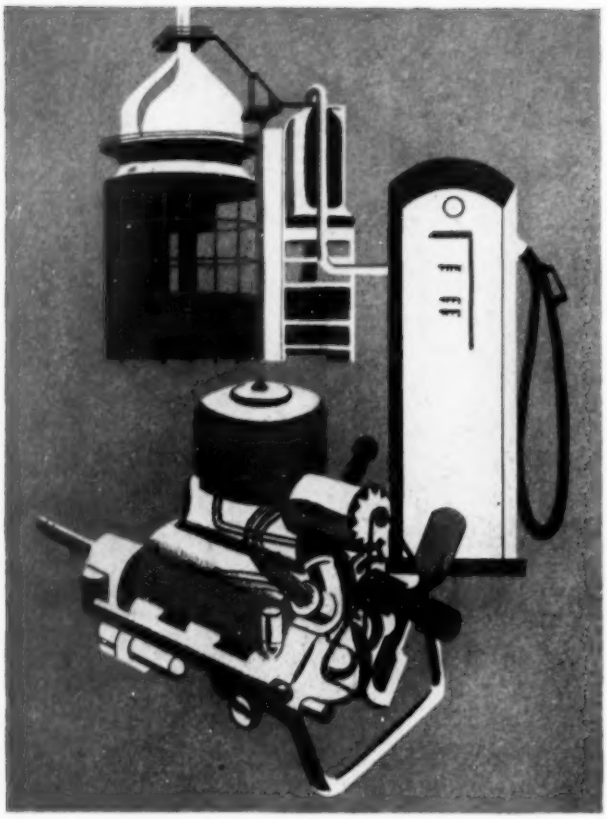

Need Octane?

REFINERS NO LONGER NEED TO BUY THE HIGHEST PRICED CRACKING CATALYST TO GET THE MAXIMUM OCTANE IN CAT-CRACKED GASOLINE. WITH FILTROL SR CATALYST, THE F-1 CLEAR OCTANES EQUAL OR BETTER THOSE PRODUCED BY ANY COMMERCIAL CATALYST AT ANY PRICE.

TYPICAL COMPARISONS ON C_5—400° F. ARE SHOWN BELOW:

CATALYST	FILTROL SR		SYNTHETIC SILICA-ALUMINA	
CRUDE	TCC EAST TEXAS	FLUID MID-EAST	TCC EAST TEXAS	FLUID MID-EAST
CONVERSION	56	55.5	56	55.5
OCT. NO.				
F-1 CLR.	92.6	91.9	91.8	92.0
R.V.P.	6.3	6.7	6.4	6.8

OTHER REASONS FOR USING FILTROL CATALYSTS

1. Lowered excess butane
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4. Sulphur resistant catalysts
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9. Low attrition rate

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CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY AUGUST 1953

NOTES ON

OXO PROCESS

Although the OXO process, because of its relatively recent appearance in the chemical industry, has frequently taken technical headlines, the various steps which precede this reaction are just as fundamental to the economic success of this new method for making alcohols.

* * *

Typical of OXO processing is a plant now underway in the U. S. in which a C_7 cut is reacted with synthesis gas to make aldehyde which is then hydrogenated to iso-octyl alcohol.

* * *

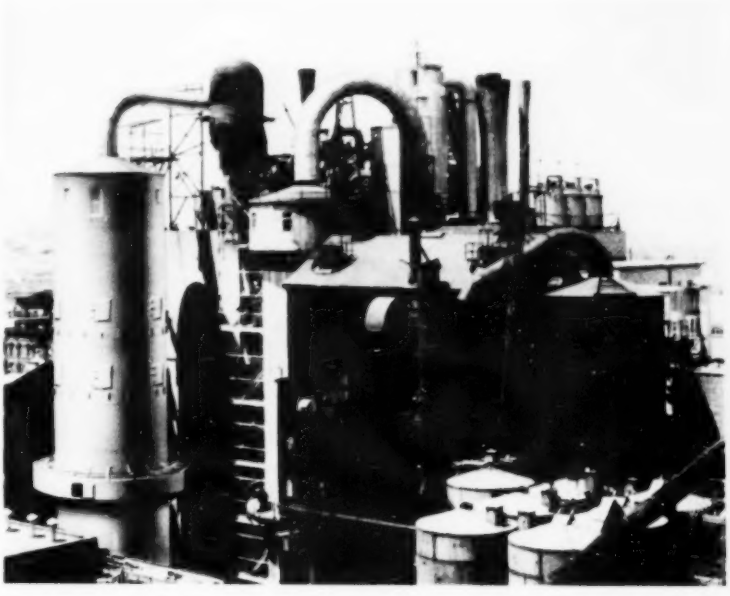
The three major feed preparation steps were all designed by Kellogg which is erecting the entire plant. These are (1) preparation of synthesis gas, (2) purification of hydrogen, and (3) close fractionation and high recovery of a C_7 heart cut from polymer gasoline.

* * *

In designing the synthesis gas reformer, particular attention was paid to flexibility in view of the novelty of the OXO process so that the composition of the gas might be varied to explore the effect of different mixtures on the yield of alcohol.

* * *

One of the novel features of the overall integration of the plant is a unique combination furnace for the production of hydrogen and synthesis gas. By providing the heating requirements for both these processes from one source, a saving in furnace cost of about 40% is effected.



Proper powder handling takes sneeze out of kitchen

One problem in the manufacture of detergents for home use lies in particle breakage. It causes sneezing in the kitchen as the housewife inadvertently inhales microscopic dust when she shakes out the "soap."

This domestic annoyance had major chemical engineering repercussions at the manufacturing level —and it brought into play a design concept usually associated with the oil refining industry.

The majority of particle breakage has occurred in the handling of huge volumes of powdered detergent following the drying step. When engineering this particular section of a new detergent plant— which is now in production— Kellogg utilized its specific experience acquired in designing scores of Fluid catalyst systems in the oil refining and chemical industries, and designed a new type of carrier system.

In essence, the unique system which involves large volumes of detergent particles cushioned on air, is a by-product of fluid processing. It gently and rapidly transports the dried detergent to the top of a six-story building for further processing with minimum production of "sneezing powder."

Montecatini Urea Process Saves on Utilities Costs

One of the major economic advantages of the Montecatini urea process lies in very significant utilities savings. These are brought about by maintaining the recycle of carbamate, ammonia and carbon dioxide in a liquid state rather than separating these components and then recompressing before charging them to the reactor.

Thus, in comparison with other urea processes on the market, it's a case of pumps vs. compressors— at a saving in utilities computed to be about 25%.

(SEE REVERSE SIDE)

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CHEMICAL PROCESS NEWS

CONTINUED FROM PRECEDING PAGE

Polyethylene Plant Now in Engineering

Engineering is well underway on a large polyethylene plant Kellogg is soon to erect in Tuscola, Ill., for the National Petrochemical Corporation.

When complete, at a cost of several million dollars it will produce 50 million pounds annually of this important basic material. The process is licensed by Imperial Chemical Industries, Ltd., of England.

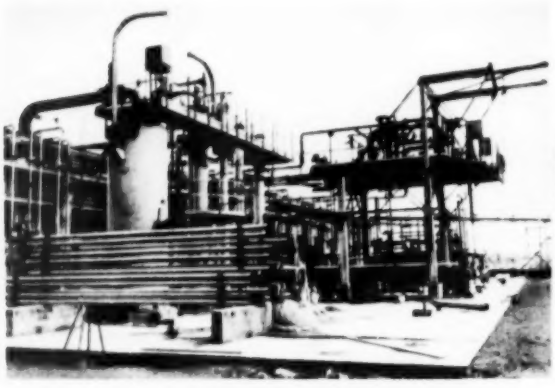
To a large extent, Kellogg's familiarity with the polyethylene process stemmed from another recent contract. This one involved the processing and erection of an ultra-high purity ethylene plant for ICI, the product from which is charged directly to a polyethylene plant.

In the work concerned with the design and construction of this plant (it produces 99.94% pure ethylene) Kellogg developed a close association with ICI which led to its present familiarity with the problems of manufacturing polyethylene.

High Pressure Ammonia Plant Nearly Ready

Insulating, weather-proofing and painting stage has been reached in the erection of this ammonia plant on the West Coast. It is well over 75% complete.

When on stream it will employ not only Kellogg's unique reactor for the synthesis step but also an unusual design in the reformer which avails itself of the high pressure of natural gas. Thus 25 to 35% in compressor cost is eliminated at no loss to the effectiveness of the reforming operation.



Solexol® Marine Oil Unit for Norway

Part of a two-phased program for the processing of fish oils, this Solexol unit (above) is well underway for De-No-Fa in Norway. It employs propane to effect fractionation and decolorization in a process perfected in the Kellogg laboratories. It fractionates the oils into varied high and low-iodine grades which nominally are used in the production of margarine.

However, when desired, the unit may also be used for the production of a clean feed stock for a fat splitter (right above) Kellogg is erecting simultaneously. Typical of two units MWK has designed and erected in the United States, the new plant has strategic importance for Norway in that it will double the production of domestic glycerine.

Typical Current Kellogg Chemical Plant Contracts

- ★ Phenol-from-cumene (2)
- ★ Iso-octyl-alcohol
- ★ Ethylene
- ★ Polyethylene
- ★ Ammonia
- ★ Phthalic Anhydride (2)
- ★ Glyceride Purification
- ★ Liquid Fuel and Chemicals Synthesis from Coal

For further information, technical data, etc., relating to chemical or petrochemical processing, write

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Sales representative for **TENNESSEE EASTMAN COMPANY,** division of **EASTMAN KODAK COMPANY**

On these pages are five examples of the variety of heavy-metal equipment designed and built by Alco to solve scores of new industrial problems. Each was made possible by two important factors.

First: Alco is thoroughly familiar with industry's needs. Its designers and engineers have worked closely for many years with power, petroleum, chemical and manufacturing companies in all parts of the world.

Second: Alco has the complete production and testing facilities required to handle efficiently and economically nearly every type of metal fabricating operation.

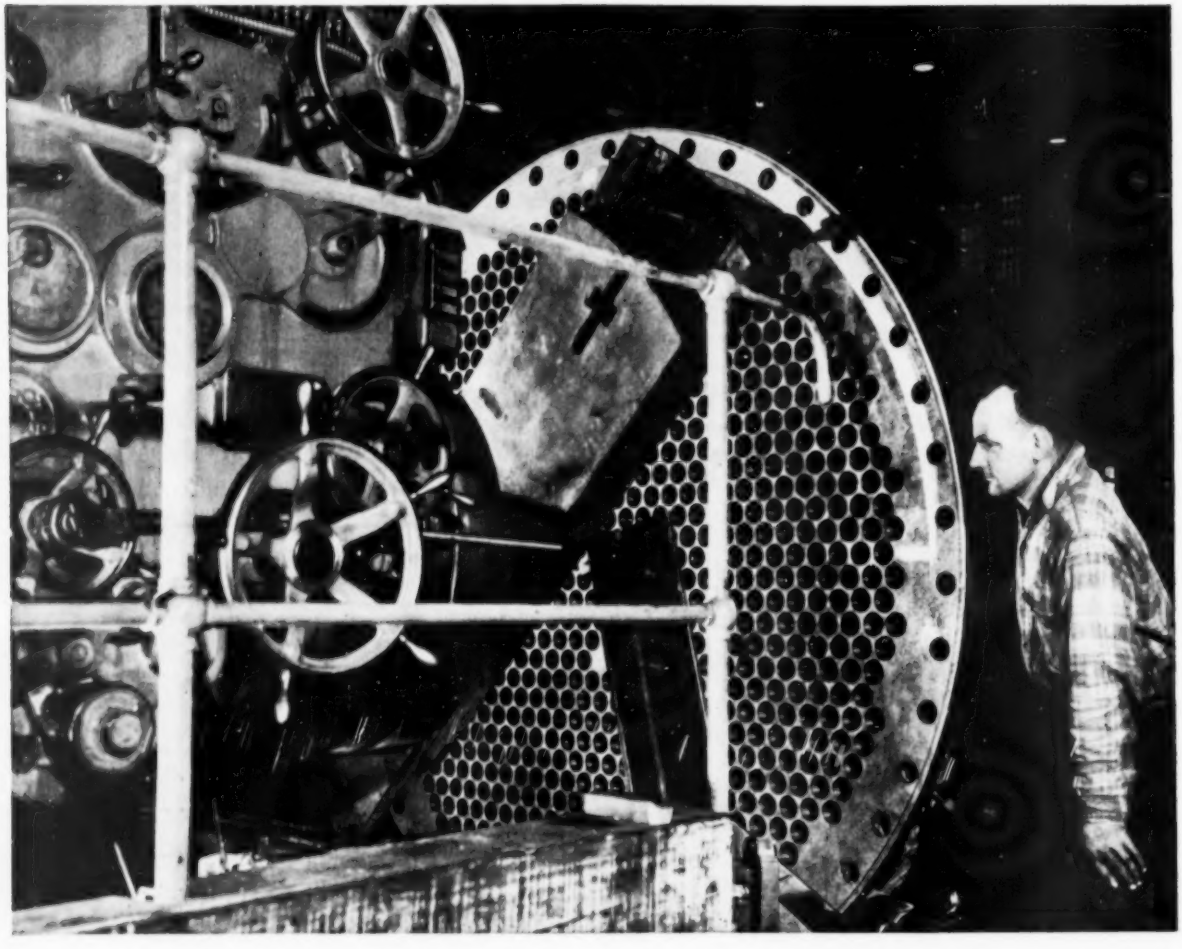
Remember these factors next time you have a problem that calls for something extra in heavy-metal equipment. Then contact your nearest Alco Products Sales Engineer at New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa or Beaumont; or write direct to Dunkirk, N. Y.

How ALCO designs

Answers to

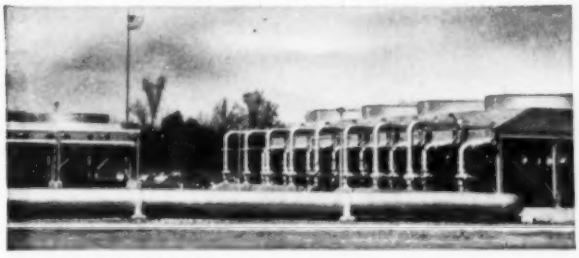
Alco

COMPLETE PRODUCTION FACILITIES, backed by years of experience, enable Alco to fabricate all types of heavy-duty power and processing equipment to meet virtually any specifications. Shown here is a specially designed flange-facing machine in operation at Alco's 31-acre Dunkirk plant.



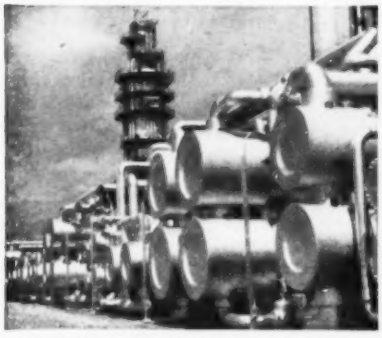
and builds...

New Industrial Problems



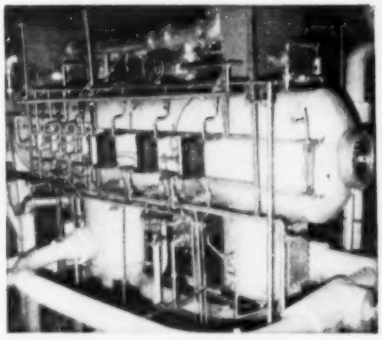
ALCO AIRCOOLERS—the economical answer to a wide range of cooling problems—handle a major part of the heat dissipation at Transcontinental Gas Pipeline Company's modern compressor station at Spartansburg, S. C. Transco also installed these versatile Alco units at their stations near Comer, Ga., and Reidsville, N.C.

ALCO ELECTRIC WELDED STEEL PIPE, available in diameters up to 120 in., is now giving low-cost, high-capacity service in water, gas, oil and sewer installations throughout the country. Furnished in sizes limited only by shipping considerations, Alco pipe helps cut installation time to an absolute minimum.



CUSTOM-BUILT HEAT EXCHANGERS were among the variety of Alco equipment specified for Esso Petroleum Company Limited's giant new refinery at Fawley, England. The largest refinery in Europe, Fawley produces fuels, solvents, lubricating oils and other products at the rate of over 6,000,000 tons a year.

DE-ETHANIZER TOWER was built by Alco to meet the strict requirements of Tennessee Gas Transmission Company's new gas processing plant at Gabe, Kentucky. Years of experience and the most modern manufacturing facilities enable Alco to produce heavy-metal equipment for nearly every purpose.



FLEX-TUBE EVAPORATORS at Florida Power Corporation's Bayboro plant at St. Petersburg, Florida, produce 7000 pounds per hour of vapor with a guaranteed purity of 0.9 ppm, based on 2480 ppm shell concentrate. Removal of scale on tube surfaces is greatly facilitated by Alco's patented Flex-Tube construction.

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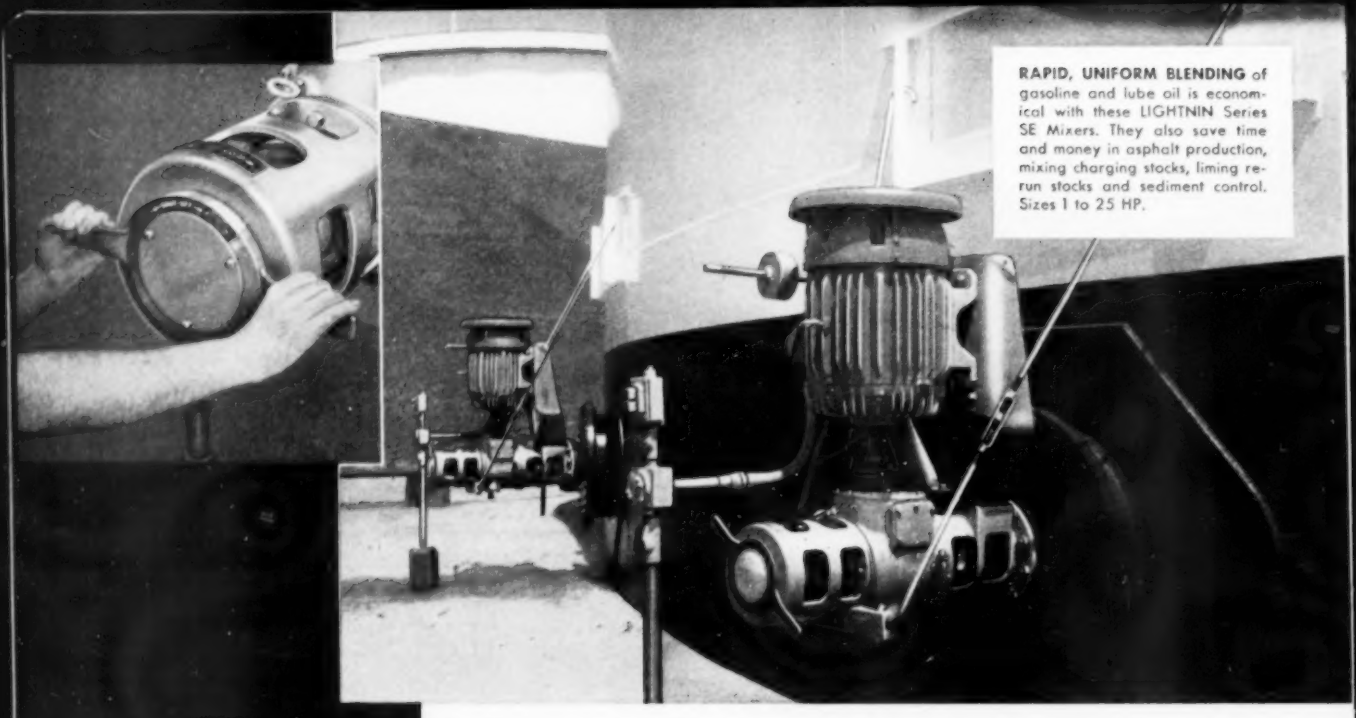

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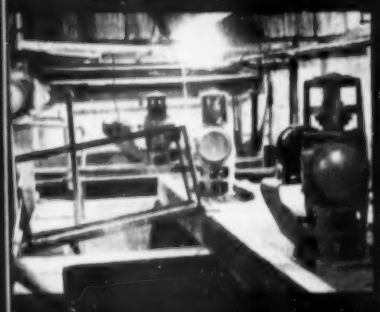

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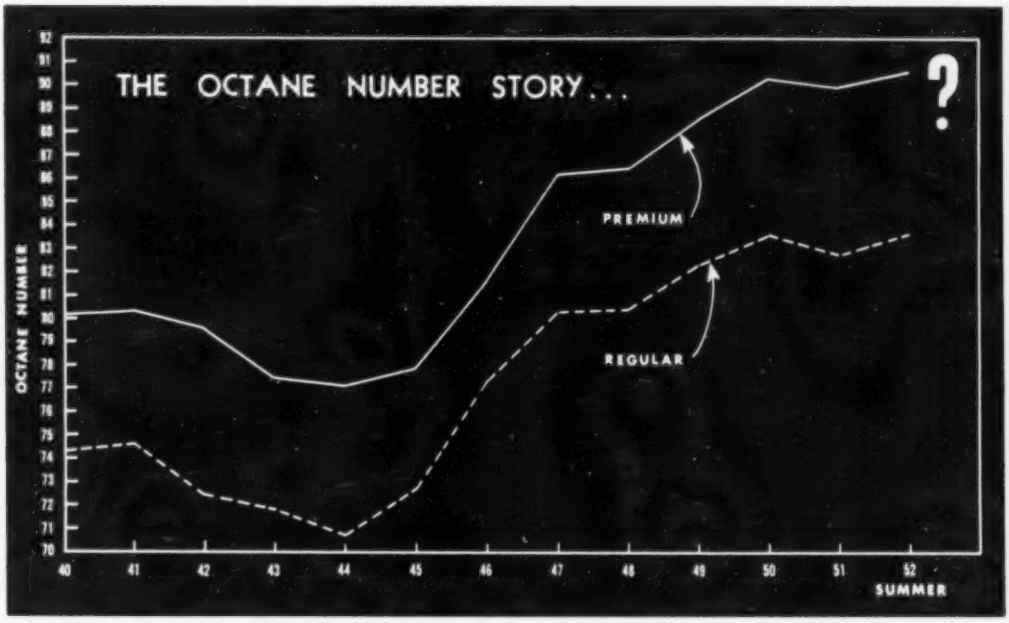


. . . premium and regular both dropped during the war when lead was short, then went up postwar about 10 numbers (of which about 5 was due to change from Motor to Research rating in 1946) and now the

Accent Is on Premium Octanes

By V. B. GUTHRIE, Editor

THE outlook for the refining industry by the end of 1954 is:

1—For 93 Research octane number for premium motor gasoline sold in the U. S. This compares with a 90.6 octane arithmetic average for premium in the summer of 1952, in the Bureau of Mines National Motor Gasoline survey, latest official data.

2—For 94 Research number for premium in the northeast and New England, with some estimates as high as 95. The rating of premium in many cities in this territory was 91.8 in the Bureau of Mines summer of 1952 survey. The arithmetic average in some of these northeast cities was 93 this April, in the Quarterly Motor Gasoline Survey conducted by the Petroleum Chemicals Division of duPont.

3—The trend in the octane number of regular grade gasoline will be upward too. Some oil companies, however, foresee a gradual widening of the spread between regular and premium grade octane numbers, because of more intensive competition quality-wise in the premium grade field. One of the large companies marketing nationally believes the spread will widen by two points in the next two to three years. This trend follows the pattern shown in the Bureau of Mines surveys. There the spread between regular and premium in 1952 was around 7 points, compared with 6 in the years immediately after the war.

The above forecasts of premium grade motor fuel octane numbers by 1954 are the average of estimates supplied PETROLEUM PROCESSING by many oil companies over the country. The continued upswing in octane ratings, and perhaps even an acceleration of that for premium gasoline, is possible because the oil industry now has developed seven commercial catalytic reforming processes for upgrading the lower octane gasolines they make by thermal and catalytic cracking.

At least 410,000 b/d charge capacity of catalytic reforming is now installed or contracted for, in the plants of over 40 refining companies. Some authorities believe this will be increased to around 550,000 b/d in the next few years.

Also, supplies of lead antiknock compound, short during the war, are again available to refiners to meet all demands for improving motor fuel octanes by this means. One lead compound manufacturer estimates a 7% increase in lead dosage in 1953 over 1952, due in part to the increase in the volume of gasoline treated.

Role of "Cat" Reforming

The part which catalytic reforming will play in allowing refiners to achieve these anticipated octane values was reported by Atlantic Refining Co. technologists at the API Refining Division 1952 meeting.[1] These same conditions exist today and they may even be emphasized through the impetus to the volume of refining operations given by the national defense effort.

"Regardless of opinions on the fundamental economic merit of high-compression ratio, and despite the very worthwhile contributions of the automotive designers in building 'mechanical octanes' into their engines, it is quite apparent that octane requirements will continue to increase for some time to come . . . . . It is expected that the average premium fuel will increase to 96 and regular-grade to 88 F-1 octane number by 1955 . . . . . .

Table 1—Gasoline Octane Trend

	1940	1950	1955
Crude run, 1000 b/d	3,500	5,700	7,000
Gasoline, 1000 b/d	1,600	2,800	3,400
Regular-grade gasoline:			
% by vol.	89	73	73
CFR Research oct. no.	76	83	88
TEL addition, ml.	1.4	1.8	2.5
Premium-grade gasoline:			
% by vol.	11	27	27
CFR Research oct. no.	83	90	96
TEL addition, ml.	2.5	2.2	2.5
Total gasoline octane:			
CFR Research oct. no., with TEL	76.7 plus 1.5	84.9 plus 1.9	90.2 plus 2.5
CFR Research oct. no., without TEL	66	74.5	79.5

"If any such increase in octane is to be obtained, a major job (for refiners) lies ahead", they stated. Some idea of the magnitude of the task is shown in Table 1, from their paper.

The average motor fuel produced in 1940 was about 66 Research octane number, without the addition of TEL and ten years later, after the great swing to catalytic cracking, the octane value had increased to 74.5, without leading. For 1955, it was assumed that the average TEL content would be increased to 2.5 ml. per gallon, since this is regarded as the most economical way of increasing octane. Having increased the TEL content, the base octane of average motor fuel production in 1955 must still be increased 5 points to 79.5 in order to meet the predicted increase in octane values.

Applying 1950 processing operations, without catalytic reforming, to 1955, these authorities concluded that, if the crude rate is expanded to an anticipated 7,000,000 b/d, and the announced 610,000 b/d of new catalytic cracking capacity is installed, the base octane of the gasoline produced would be only 75.1. This is considerably below the 79.5 octane for base gasoline shown in Table 1 as required to meet the predicted octane values of 1955, of 88 Research for regular and 96 for premium.

These authors go on to point out that if 500,000 b/d of catalytic reforming operation, at an 87% debutanized reformate yield, is added to the picture of refining operations given in Table 1 for 1955, the base octane then becomes 79.6 Research and the projected 1955 gasoline quality can be met with 2.5 ml. TEL. Table 2, also from this paper, shows the composition of gasoline, based on their projected 1955 processing of crude.

Table 2—Gasoline Composition—Projected 1955 Crude Processing

Component	% by vol. of crude	CFR Research Octane No.
Light straight-run naphtha	10.5	75.0
Heavy straight-run naphtha	3.4	55.0
Catalytically reformed naphtha	7.2	86.0
Ther. cracked and reformed naphtha	13.1	74.0
Cat. cracked polymers and alkylate components	14.3	90.0
Total blended gasoline	48.5	79.6

Since the time this report was presented, our sights as to the volume of crude to be processed in 1955 have been raised to around 7,250,000 b/d avg. On the basis of 7.2% yield of catalytically reformed naphtha, as shown in their Table 2, the required amount of catalytic reforming charging capacity would be raised to around 525,000 b/d.

Favorable for Small Refiners

In the coming period of competition for motor fuel business quality-wise, the smaller refiners, in one respect at least, are in a much more favorable position than when catalytic cracking was introduced. Units of any of the five commercial catalytic reforming processes available can be installed with charge capacities as low as 600 b/d. Catalytic cracking units in the early years ran several thousand barrels capacity.

Catalytic reforming units can be installed today at a cost, inside battery limits, of around $250 per barrel of charge, it is said, while catalytic cracking units cost $500 to $600 per barrel charge capacity.

A list of the Platforming catalytic reforming units of Universal Oil Products Co. shows units installed or contracted for in 43 plants in the U. S., for a total of around 245,000 b/d charge capacity, and 28 units are in plants of the smaller refining companies. They range in capacity from 600 to 4500 b/d charge.

In addition to the 245,000 total bbl. capacity of Platforming units in this country, built or announced, it is estimated that around 165,000 bbl. of six other processes are in operation or being arranged for.

These are Atlantic Refining Co.'s "Catforming," Houdry Process Corp.'s "Houdriforming," Standard Oil Co.'s (New Jersey) Fluid reforming, Socony-Vacuum Oil Co.'s Thermofor Catalytic Reforming, Sinclair Research Laboratories new process, and a new one just announced as a development by Standard Oil Co. (Indiana) and Pan American Refining Corp. UOP's Platforming, the first commercial process to be announced, dates back only to 1949. The newest, the Indiana Standard-Pan American process, is to be installed in a 21,000 b/d unit at Pan American's Texas City refinery, with M. W. Kellogg Co. as constructor.

The smaller refiners for the most part will let the larger companies take the lead in pushing up the octane ratings of motor gasoline, as they have done in the past. However, one independent refiner has already jumped into the lead with a super premium selling a cent higher than conventional premium fuels. This is Leonard Refineries, Inc., Alma, Mich. It unveiled its "SuperX-Tane" 96 Research octane gasoline a few weeks ago, before an invited group of automotive and petroleum industry representatives. The Leonard gasoline is claimed to develop 10% more power than 91.5 octane premium gasoline in standard late model engines.

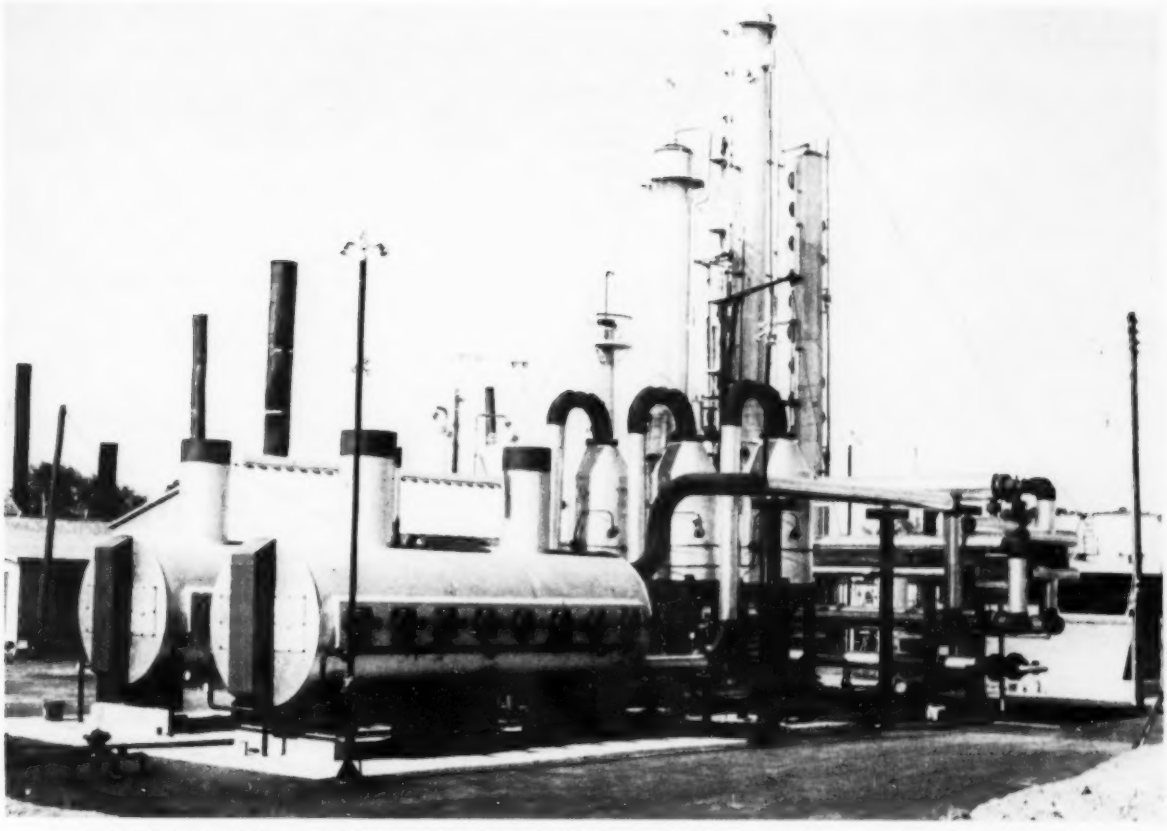
Small refiners in general, however, have been satisfied to stay "right behind" rather than ahead of the larger companies in boosting octanes. As one of them pointed out, there is a feeling that the motoring public might be getting a lot more octane than it really needs. A small independent, however, is usually not in a position of being able to determine accurately the percentage of his customers who actually need the higher grade gasoline. But, being competitive with the larger firm, he must recognize the octane trend is up.

One other approach to high octane requirements has been the TCP additive announced recently by Shell Oil Co. It is claimed to boost power as much as 15% and provide 150% longer life for sparkplugs. The material, now available in Shell's premium gasoline, is designed to nullify the harmful effects of certain metallic deposits on plugs and other deposits in the combustion chamber. The company contends these deposits cause faulty plug operation, especially when the engine is accelerating.

A story of how one small independent refiner met a rather complex octane problem appears in this issue. McBride Refining Co. of La Blanca, Texas, is *not* in a high octane demand area. Nevertheless, company officials recognized the potential trend. They decided to install catalytic reforming so as to obtain an optimum yield of premium gasoline and continue to make no more than marketable quantities of regular grade. For details and cost estimates, read Southwestern Editor Dave Thornton's account, beginning on the next page.

(1) "Tomorrow's Octanes", M. J. Fowle, R. D. Bent, G. P. Masologites, Atlantic Refining Co.; presented at the 17th Mid-Year Meeting, API Division of Refining, San Francisco, May 12-15, 1952.

NOTE: Data in tables from above API paper. Data in chart from U. S. Bureau of Mines National Motor-Gasoline Survey.



750 b/d ATLANTIC CATALYTIC REFORMING UNIT at McBride's 2000 b/d refinery: topping unit visible in background (photo courtesy Grebe & Doremus)

ACCENT WAS ON PREMIUM

How a Small Plant Makes Octanes

By D. P. THORNTON, Jr.
Southwestern Editor

HOW can the small refiner keep abreast of competition in the gasoline octane race? For some the answer may be the purchase of outside high-octane blending stocks to upgrade motor fuel. Others may find some form of catalytic cracking solves this problem and provides greater processing flexibility.

McBride Refining Co. was one of the category of small refiners facing an octane problem. It found the answer in catalytic reforming, installing a 750 b/d (design capacity) Atlantic "Catformer" in its 2000 b/d refinery near La Blanca (in the Rio Grande "Valley" about eight miles east of Edinburgh, Texas).

With almost a year's operating experience now to back up results anticipated when the unit was authorized, McBride is convinced its octane problems are solved for the foreseeable future and the plant improvement amply justified.

In this particular case, the crude stocks charged do not produce a sufficient quantity of gas oil to make either thermal or catalytic cracking attractive from the octane standpoint. However, being comparatively light crudes, the recovery of straight-run gasoline is rather high. Hence the need centered around some means of upgrading straight-run naphtha which could be installed at minimum investment and operating cost to provide a high-octane product in the highest possible yield. The Atlantic catformer, installed by Grebe & Doremus Process Corp., Houston, has demonstrated its ability in this respect and proved capable of handling up to 1000 b/d of charge stock.

What was the existing situation?

The feasible marketing area which McBride can practically serve is, for the most part, confined to "regular" grade gasoline. Unlike conditions in some other parts of the country, a potential market of 10% or more of gasoline sales as "premium" grade just does not exist—it's too far to water transportation and the plant is not large enough to quickly accumulate cargo quantities without incurring excessive dockside storage charges. Moving the stock elsewhere inland involves bucking greater transportation costs and selling the material in some other refiner's backyard.

So, the plant is "stuck" with a marketing area capable of absorbing a relatively small, but nonetheless definite, quantity of "premium" gasoline. Likewise, the volume of "regular" which could be disposed of is not capable of supporting any greatly *increased* refinery capacity. McBride has competition from other Independents and major refiners.

In short, the company needed flexibility and a process which could upgrade an optimum quantity of whatever feedstocks were available to meet a small and definite market for high octane fuels.

In pre-reformer days, McBride sold

Table 1—Charge Stocks for Catalytic Reforming

	Donna Crude	La Blanca Distillate	S. Texas Mixed-base Crude
Gravity, °API	56	63	54.4
Vapor Pressure, psi. Reid	5	6	3.7
Color	30+	30+	30+
Aniline Point	125	150	...
Total Sulfur, %	0.001	<0.001	Approx. 0.001
ASTM Distillation, °F.:			
IBP	115	110	133
10%	195	190	201
50	265	265	277
90	340	340	352
EP	385	385	401
Research octane, clear	56	30	60
Pod-Poma Analysis, vol.-%			
Paraffins:			
C_4^-	1.8	1.6	Not Available
C_5	2.8	3.8	...
C_6	8.0	6.4	...
C_7	7.8	14.9	...
C_8	10.8	18.5	...
C_9	10.2	15.7	...
$C_{10}+$	9.2	13.7	...
	50.6	74.6	
Naphthenes:			
C_6	15.9	9.5	...
C_7	12.0	6.5	...
C_8	5.3	2.8	...
C_9	1.9	0.9	...
$C_{10}+$	1.4	0.5	...
	36.5	20.2	
Aromatics:			
C_6	1.0	1.4	...
C_7	2.2	1.0	...
C_8	4.7	1.3	...
C_9	3.5	0.9	...
$C_{10}+$	1.5	0.6	...
	12.9	5.2	

Table 2—Inspection of Catalytic Reformed Product

	Donna Crude	La Blanca Distillate	S. Texas Mixed-base Crude
Yields, % of feed as:			
10-lb. Rvp reformate, vol.-%	99.9	95.9	99.8*
Excess butanes, vol.-%	−3.2	−0.2	−2.8*
Propane, vol.-%	4.6	4.2	...
Ethane, wt.-%	0.3	0.3	...
Methane, wt.-%	0.1	0.1	...
Hydrogen, wt.-%	0.6	0.2	...
Octanes, Research:			
10-lb. reformate, clear	80.2	66.4	80.8
With 3 ml. TEL/gal.	93.5	84.5	94.0*

* Calculated from 5.5-lb. Rvp product showing 97.2% yield and 93.5 oct. Research.

on the order of 1,200,000 gal./month of 83 oct. (Research) "regular" gasoline and about 40,000 gal. monthly of 88 oct. "premium". The plant has a simple 2000 b/d topping unit.

Charge stocks were alternately 45,000 bbls. per month of La Blanca distillate, containing 60% of gasoline testing 30 oct. research, and 15,000 bbls. per month of Donna crude, having a typical Mid-Continent composition producing a 56 Research gasoline. Inspections of these two stocks are shown in Table 1, wherein it will be noted that La Blanca is not typical of the usual distillate.

It is obviously impractical to produce "premium" grade gasoline from the straight-run distillate. In fact, profits take a beating making "regular" from it unless the stock is undercut to about 350 end-point. This automatically cuts McBride's effective gasoline production from it by 15%, or to 51% on crude, and the rejected material could be sold for 1c a gal. less if moved as white gasoline and 1.75c less if dropped into kerosine.

In practice, the distillate gasoline was undercut to 350 e.p and blended with Donna gasoline. Natural gasoline was blended in as needed to help make up gallonage and also as a revenue-producer in its own right. For "premium" a high-cost high-octane polymer or a catalytically-cracked naphtha also was used with Donna gasoline and casinghead. In both cases 3 cc. of lead was required.

What has catalytic reforming done for McBride?

The availability of catalytic reformed gasoline made a radical difference in the plant's motor fuels picture. Summed up, the advantages are these:

1. Most important, the plant can produce both "premium" and "regular" gasolines from any available stock without buying any outside high-octane blending agents.

2. Only slightly less important, no gasoline need be lost into kerosine through undercutting. A full 100-400° boiling range material can be used without an octane or lead "penalty".

3. A "premium" gasoline may be made with less than 3 cc. of tetraethyl lead and without greatly reducing total gasoline make or sacrificing quality of "regular" gasoline.

4. The plant can make a 96 oct. Research "premium", if and when necessary, without purchase of outside "high-octane" blending agent.

The reformer in effect has been inserted between the topping unit and blending facilities in the plant flow scheme. The unstabilized water-saturated straight-run gasoline is preheated by exchange with reformate, then heated to reaction temperature. There are three reactors in series and effluent from the first and second are reheated before entering the next reactor.

The reformate at 500 psi. is separated from hydrogen and other make gas in a high-pressure separator, most of which is recompressed and recycled as 90% hydrogen into the charge ahead of the preheat exchanger. The excess is diverted to fuel gas. A flash chamber ahead of the plant stabilizer reduces the vapor load on the stabilizer and lets reformate down to stabilizer pressure, flashed gas going to fuel. Overhead vapor from the stabilizer is used as reflux, with excess rejected to fuel gas or condensed for sale as a propane-butane mixture.

The physical aspects of the unit are quite compact, as shown by the accompanying photograph. The plant itself is scattered over a 15-acre tract to minimize fire hazards.

The results from reforming the La Blanca distillate and Donna crude are shown in Table 2. On the basis of a 10-lb. Reid vapor pressure, the La Blanca reformate tests 84.5 Research with 3cc. lead and the Donna gasoline has jumped to 93.5 Research. Since the respective yields are 95.9% and 99%, mild reforming conditions were used in processing both stocks. Natural gasoline is blended with "regular" to increase gallonage.

At the same level of crude runs used before installing catalytic reforming, sales have run 1,600,000 gal./month of "regular" testing 86 Research. This is three octane points higher than the previous fuel. "Premium" sales have climbed to 80,000 gal. monthly, the fuel testing approximately 91.5-92 Research as before.

As this is written, the plant is in the midst of a switch in charge stocks. Donna crude will no longer be run. As initial replacement for Donna, a South Texas mixed base crude is being charged for the first time. This later will be supplemented by another South Texas paraffinic crude.

Inspection of the South Texas

mixed base crude is shown in Table 1. Testing 60 oct. Research as a straight-run charge to reforming, the reformed product at 10-lb. vapor pressure tests 80.8 unleaded and 94 oct. leaded (3 cc. T.E.L.) with a yield of 99.8%. Data from the paraffinic South Texas crude will not be available for some time, but similar yields and reformate quality are anticipated.

What are the economic aspects now, with reforming?

McBride's unit cost approximately $225,000. For illustration, one possible analysis of operating revenues is shown in Table 3, based on charge stock from the $3.15 per bbl. (laid down) mixed-base crude.

Two cases have been taken. Case I may be likened to the former operation when topping only was possible. The plant makes 84 oct. (Research) regular, 88 oct. premium, and white 395 e.p. gasolines. Here, it is assumed that the plant buys both natural gasoline at 9.5c per gal. to mix 50-50 with straight-run and high-octane blending agent at 15.25c per gal. to add 15% to the 50-50 mixture of straight-run and natural gasoline destined for sale as premium grade. Under these assumptions the gross operating revenue is 1.27c per gal.

In Case II topping is followed by reforming of 395 end-point stocks destined for sale as 91 oct. (Research) premium and 86 oct. regular grades. Both grades bring 0.25c per gal. more because of their higher quality. White gasoline is not reformed. The sales volume of Case I is assumed. There is one other important change: no "outside" high-octane blending stock is needed. The operating revenue of Case II is 1.29c per gal. This is an increase over the revenues of Case I of 0.02c per gal.

This analysis, which does not necessarily reflect actual operating revenues at La Blanca now the reformer has been added, is presented to show that a reformer was a necessary refinery unit if the plant was to remain competitive in its trade area. The situation in probably most any other refinery would be entirely different, if for no other reasons than because of different utility and labor costs (affecting reformer operating cost), differences in charge stocks and, very likely, the comparative ratio of premium to regular grade gasolines which might be marketed.

Indeed, there are other factors which might have been considered in Table 3. Among them, for instance, is the fact that McBride does not now stabilize reformer feed to around 200° initial. Admittedly these light ends get a "free ride" through the reformer. Thus, reformer charge could be effectively increased by around 10% with a minor change in operating cost through this move alone; perhaps by reforming additional stabilized natural gasoline and with additional credit coming from increased sales of propane-butane mixtures.

McBride definitely feels that the reformer has pulled its feet from the fire and is well-pleased with the extremely flexible operation which it did not have previously. Octane is no longer a serious problem. Moreover, the refinery now can utilize whatever crude and distillate stocks may be available in producing these high-quality motor fuels. And, with chemical plants nearby, it may prove feasible in future for the plant to profitably dispose of some of its stocks in the gasoline boiling range as chemical raw materials.

Table 3—Economic Analysis of Topping and Topping with Reforming

Crude Yields	Vol.-% of crude
Products:	
Straight-run gasoline, 395 e.p.	25.5
Kerosine	16.6
Light Diesel fuel	32.6
Heavy Diesel fuel	5.4
Topped crude sold as such	19.0
Processing loss	0.9
	100.0

CASE I—*Straight topping only. Produce 88 oct. (research) "Premium", 84 oct. (research) "Regular", and 3rd grade gasolines; all cut to 395 e.p. from straight-run gasoline.*

Primary Products	Yields, % on crude	Selling price c/gal.	Average sales price c/gal.	Extended totals
Premium gasoline	2.5	12.75	0.32	...
Regular gasoline	20.5	11.75	2.41	...
Third grade gasoline	2.5	10.75	0.27	...
Kerosine	16.6	9.25	1.54	...
Light Diesel fuel	32.6	8.75	2.85	...
Heavy Diesel fuel	5.4	7.75	0.42	...
Topped crude	19.0	6.25	1.19	...
Processing loss	0.9	...	(0.07)	8.93
Credits				
Natural gasoline blending				
50-50 blend*			...	...
Premium, 0.025(12.75-9.5)			0.46	...
Regular, 0.205(11.75-9.5)			0.08	...
3rd grade, 0.025(10.75-9.5)			0.03	0.57
Debits				
Leading blends to 95 cc/gal.; (0.205 + 0.025)0.75 × 2			(0.35)	...
High oct. blending stock, 15 vol.-%** 0.025(0.15)2(15.25-12.75)			(0.02)	...
Topping cost, 1.00(0.36)			(0.36)	(0.73)
TOPPING GROSS REVENUE				
Average selling price, c/gal.				8.77
less crude cost ($3.15/42)				(7.50)
Gross revenue from topping				1.27

* Laid-down cost, 9.5c/gal.
** Laid-down cost, 15.25c/gal.

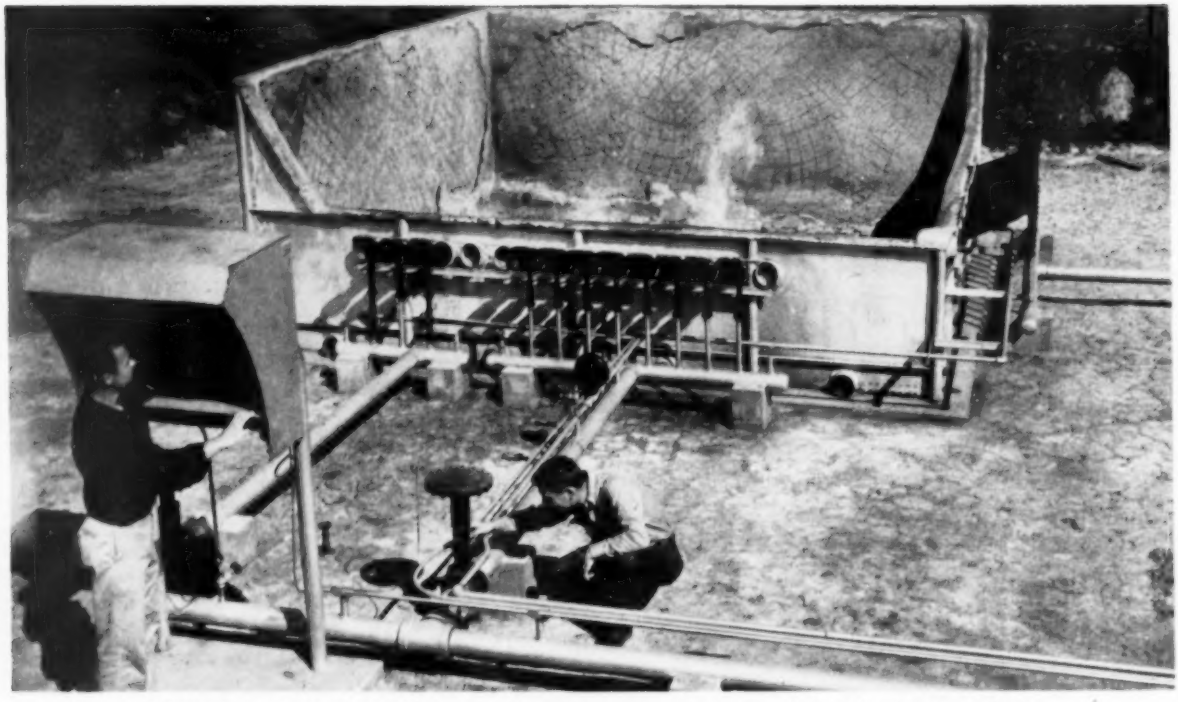
CASE II—*Topping and catalytic reforming (at 750 b/d). Produce 86 oct. (research), 91 oct. (research), and third grade. No outside blending stock.*

Primary Products	Yields, % on crude	Wet Yield Factor*	Selling price c/gal.	Average sales price c/gal.	Extended Totals
Premium gasoline	2.5	0.972	13.00	0.32	...
Regular gasoline	20.5	0.972	12.00	2.39	...
Third grade gasoline	2.5	1.000	10.75	0.27	...
Middle distillates & topped crudes from CASE I	74.5	1.000		5.93	8.91
Credits					
Blend with natural gasoline, 50-50**					
Premium, (0.025)0.972(13.00-9.5)				0.09	...
Regular, (0.205)0.972(12.00-9.5)				0.50	...
3rd grade, (0.025)1.000(10.75-9.5)				0.03	0.62
Debits					
Leading costs:					
Premium (2.9 cc. TEL)(0.025)0.972(0.25)2.9(2)				(0.04)	...
Regular (1.4 cc. TEL)(0.205)0.972(0.25)1.4(2)				(0.14)	...
Feed preparation, 1.00(0.36)				(0.36)	...
Reformer operation: 2.8% yield loss as unleaded regular, less credit to fuel fuel gas & LPG; net 1.8%*** 0.018(12.00-0.75)0.23				(0.0467)	...
Catalyst cost, 1 lb/50 bbl. of charge @ $1/lb. [1(750/50)(400/0.23)]/[(750)42]				(0.0439)	...
Reformer operating cost @ $100/day*** [(100,000)0.23]/[(750)42]				(0.0729)	...
Royalty, 6c/bbl *** [(750)6/(750)42] x 0.23				(0.0329)	(0.74)
TOPPING AND REFORMING REVENUE					
Average sales price of products, c/gal.					8.79
less crude cost, c/gal., from CASE I					(7.50)
Gross revenue from topping *and* reforming, c/gal.					1.29

* Reforming yield loss, 2.8 vol.-%. Third grade not reformed.
** Laid-down cost.
*** Factor of 0.23 is yield on crude of reformed gasoline to convert these costs to a crude basis.

SUMMARY

Net revenue from topping, CASE I, c/gal.	1.27
Net revenue from reforming and topping, CASE II, c/gal.	1.29
Increase in revenue, CASE II less CASE I, c/gal.	0.02



BEHIND A CEMENT WALL waste gases are flared in this economical Rothschild installation

Build a Flare for Under $5,000

Use of pit instead of stack cuts construction costs; compact smokeless unit handles 2,000,000 SCFD

By ***MILTON R. BEYCHOK***
Chemical Engineeer
Long Beach, Calif.

TO ELIMINATE smog, refineries need flares designed for smokeless burning of hydrocarbons. The problem of designing such a flare increases in complexity with the number of refinery operations. The unit must be highly flexible and sensitive to changes in volume. It must be capable of handling gases of varying compositions, Btu contents and combustion air requirements.

Recently, Rothschild Oil Co. completed such an installation at its Santa Fe Springs, Calif., refinery. To date, it's been successful, with only a few minor difficulties. The unit, of the "ground" or horizontal type, cost under $5,000, and design capacity is 2 million SCF/D.

The flare is located about 300 ft. due north of the closest refinery unit, a Dubbs thermal cracker, and an equal distance due east of some crude oil storage tanks. The Santa Fe Springs refinery has an 8,500 b/d throughput capacity, 1,500 b/d thermal cracking capacity and a catalytic polymeriaztion unit.

Cost ruled out a vertical flare at the Santa Fe location, and literature on the horizontal type, it was found, is meager; however, Brumbaugh[1] has presented extensive information on this type of structure.

Rothschild's horizontal burner is built on these lines. The refinery flare header discharges to a vertical liquid trap, where liquid carry-overs are caught and drained to the sump. Dry gas then discharges to burner lines, which open on a pre-set pressure schedule. If pressure valves don't open, a clear line (with no valves in the circuit) by-passes the valves and discharges to the largest burner bank.

Burners are lighted by constantly burning pilot flames, and are enclosed on four sides by a concrete, steel-reinforced wall. This, in turn, is enclosed by an earthen retainer. Control valves and units are far enough from the combustion zone to allow safe operation and maintenance.

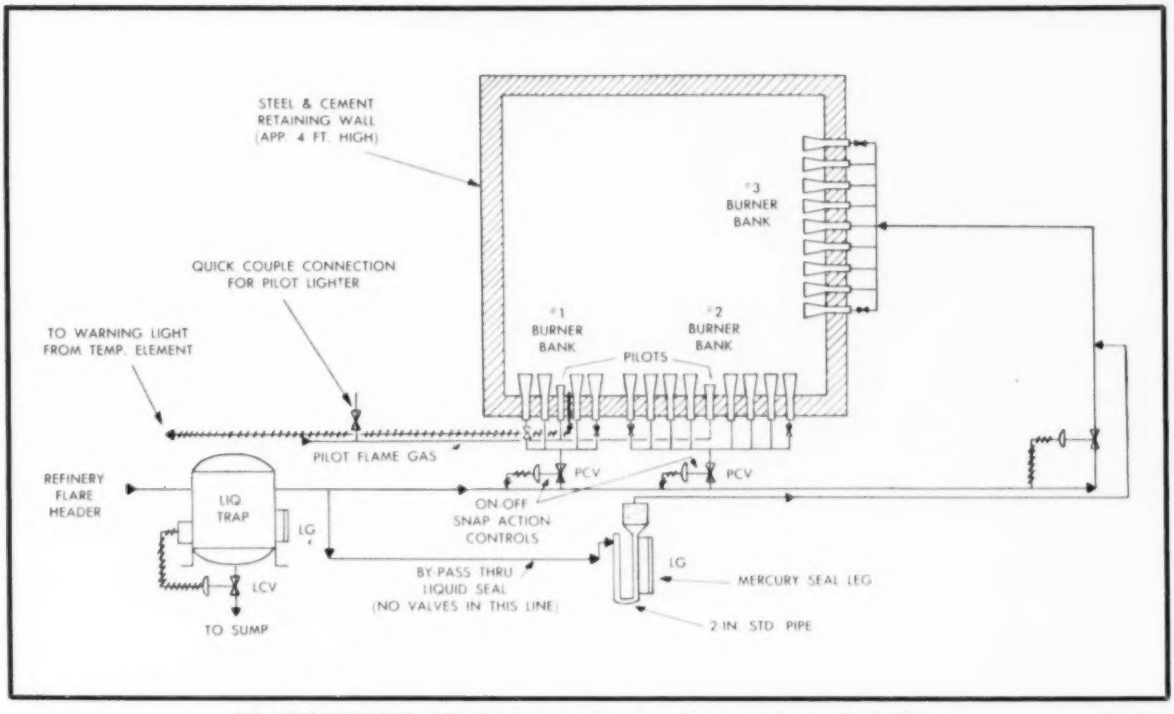
In design and construction of this type horizontal burner, many factors need consideration. It must be decided what units will need relief, when and in what combinations. Data on the quantities and composition of gases used may be available or estimated. In case of fire actual gas volumes will be augmented by considerable vaporization of liquids. In many cases, relief valves will be already "fire-sized" and data on them obtainable.

The relief header, control valves, knock-out drums and burners must be so sized that total pressure drop:

1—Will not create a back pressure at the relieving units that is more than ½ the internal unit relieving pressure. When back pressure is larger than ½ the internal relieving pressure, the relief valve will not attain sonic velocities or release its designed flow quantities. With normal design, the header line, controls, etc. should not create more than 15 psi back pressure. In such cases, only units with very low relief valve settings would be affected.

2—Will not create back pressure large enough to keep the relief valve closed until vessel design pressure is exceeded. For example, an atmospheric relief valve set at 60 psig. will not open until 70 psig. if a 10 psig. back pressure exists.

A burner cut-in schedule can be set up by estimating what quantity of gas is likely to be relieved most often. Choose a control valve to



FLOW DIAGRAM of the horizontal type flare burner at Sante Fe Springs

handle this gas at some arbitrarily low pressure, say 3 psig. Remember that pressure drop in the line and knock-out drums must be added to the control valve back pressure. Also keep in mind that sufficient pressure downstream from the control valve must be maintained for successful burner operation. Since the control valve will be either completely open or closed, the valve will have a low pressure drop. Then choose another higher pressure, say 5 psig. Estimate what quantity of gas is next most likely to need relief, and size the second valve for this second quantity. Size the third control valve for perhaps 6 psig. and the third most likely quantity of gas over and above the total of the first two. The three estimated quantities should total the maximum expected.

With the use of snap-action, on-off pressure controllers, the following scheme can be set up: (See flow diagram)

1—When the relief header pressure reaches 3 psig., the first control valve opens and the first burner goes into operation. The on-off controller is set so the valve remains open until the pressure decreases to about 1½ psig.

2—When the header pressure reaches 5 psig., the second valve opens and remains open until pressure decreases to about 3 psig.

3—When the pressure reaches 6 psig., the third valve opens and remains open until pressure decreases to 4 psig.

Summarizing the control valve schedule:

Valve	Estim. Quantity	Settings, psig — Opens	Closes	Oper. Range
1	250 MSCFD	3	1½	1½–7
2	500 MSCFD	5	3	3 –7
3	1000 MSCFD	6	4	4 –7
	1750 MSCFD Total			

Cut-off pressure of valve No. 1 must not be so low that burners will not operate as cut-off pressure is approached. The 7 psig. upper range is set by the by-pass relief line seal described below.

In the Rothschild installation, it was decided not to use one large burner per valve because large burners would have to be specially designed at high expense, and small burners with interchangeable parts are easily obtained.

MERCURY FLOW underneath liquid mercury seal is inspected by author and designer Milton Beychok

To prevent blocking the relief header if control valves fail to open, a positive relief line by-passes the valves. This line is sealed by a static head of water or any other liquid, say 7 psig. of head. In the interests of economy, Rothschild used a mercury manometer-type seal. Some difficulty has been experienced due to loss of mercury and resultant reseal failure. A more efficient baffling chamber of larger size and lower gas velocity should overcome the problem. In any event, the by-pass relief line should tie into the burner bank rather than vent to air.

One small Venturi-type burner is placed just below the center of each bank and is tied into an independent pilot flame gas source. Thermoswitch units placed adjacent to the pilot flames activate warning lights in the control house when pilots blow out. Pilots are lighted manually with a Venturi torch at the end of a section of ½-in. pipe and flexible hose. A quick coupling connection is placed in the pilot gas line for use with the lighting torch.

During installation, it is wise to provide extra piping and space for the addition of one or two more burners per bank. Also, one or two of the units in each bank should have shut-off valves.

(1) "Smokeless Burning of Refinery Vent Gases", A. K. Brumbaugh, Jr. PETROLEUM PROCESSING, 2, 168 (1947).

Pictures courtesy Arthur Adams

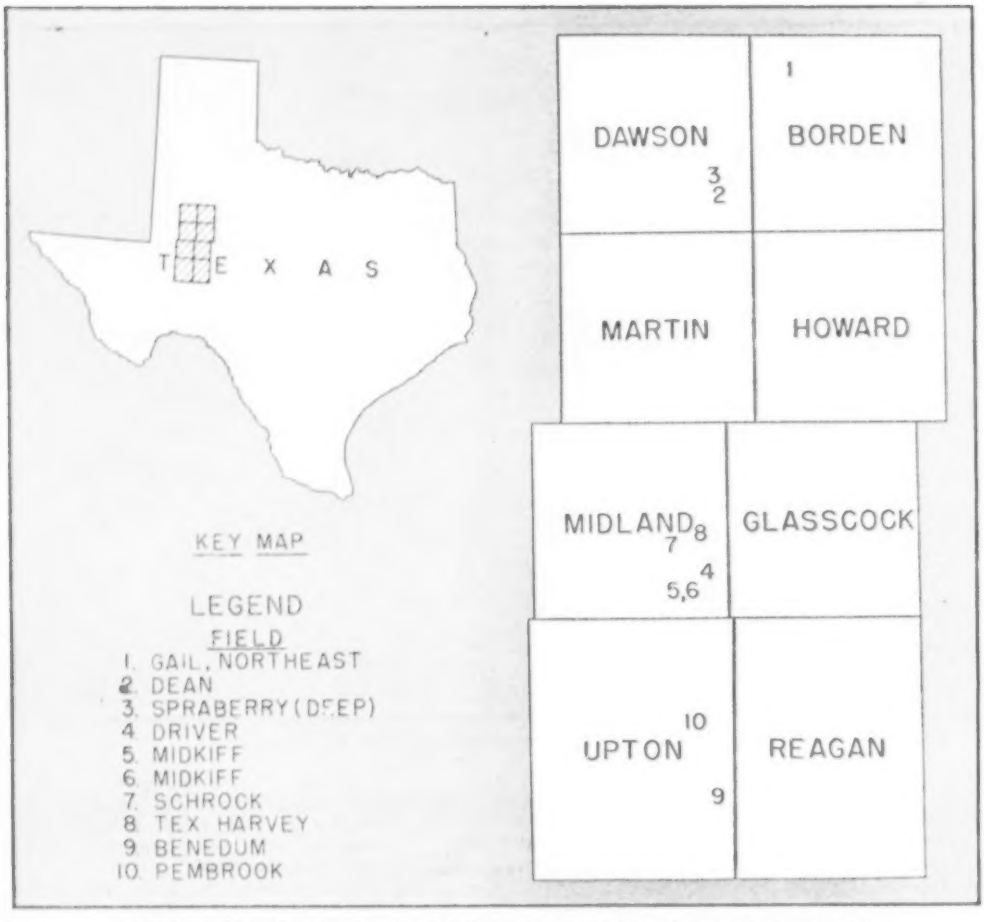


FIG. 1—Map showing location of fields from which crude samples were taken

Refining Properties of New Crudes

Part 8—Crude Oils from the Spraberry, Texas, Area

*By C. M. McKINNEY and H. M. SMITH**
Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla.

Analytical data are given for 10 crude oils produced from the Spraberry, Texas, area. The data are compared in tabulated form with data on crude oils from East Texas and the Scurry County area. Inspection data, including octane numbers and cetane numbers on gasoline and Diesel fuels, respectively, are given for two of the crude oils. Part 7 of this series, dealing with crude oils from recent discoveries in Canada, appeared in September, 1952, page 1270.

DURING the past two years considerable technical literature has appeared regarding the oil-producing area of West Texas commonly referred to as the "Spraberry Trend". The name is derived from the major producing formation, the Spraberry sand, of Permian age. Developed reserves along the trend are conceded by most geologists to be among the largest contained in any one contiguous area of the United States. However, because of unique oil-production characteristics, the Spraberry Area has been described in recent reports as one of the most extensively developed non-profitable oil-producing areas in the world.

*C. M. McKinney is a Chemical Engineer, and H. M. Smith is a Petroleum Chemist.

Table 1—Comparison of crude-oil analyses

PART 1—DATA SHOWING SOURCES AND GENERAL CHARACTERISTICS OF SAMPLES

Item	Sample	Field	County	Producing formation and age	Depth, feet	Gravity, °API	Color*	Sulfur, wt. %	Saybolt Viscosity 100° F. sec.	Carbon residue, wt. %
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	52021	Gail, Northeast	Borden	Upper Spraberry sand, Per.	5,035	31.6	B.G.	0.20	44	1.2
2	52020	Dean	Dawson	Spraberry sand, Per.	7,276–7,286	41.9	B.G.	.15	35	.7
3	52022	Spraberry (Deep)	Do.	do.	6,770–6,811	37.2	B.G.	.17	41	1.4
4	52018	Driver	Midland	Upper Spraberry sand, Per.	.....	37.0	B.G.	.19	46	1.4
5	52014	Midkiff	Do.	Spraberry sand, Per.	.....	37.2	B.G.	.18	44	1.3
6	52015	Midkiff	Do.	do.	.....	37.6	B.G.	.18	44	1.3
7	52013	Schrock	Do.	Upper Spraberry sand, Per.	7,000	37.6	B.G.	.21	45	1.3
8	52019	Tex Harvey	Do.	do.	7,010–7,110	38.4	B.G.	.16	41	1.2
9	52017	Benedum	Upton	Lower Spraberry sand, Per.	.....	40.2	B.G.	.14	41	.8
10	52016	Pembrook	Do.	Upper Spraberry sand, Per.	.....	36.8	B.G.	.22	45	1.5
11	50029	Snyder, North	Scurry	Canyon Reef ls., Penn.	6,260–6,419	43.4	B.G.	.22	36	1.0
12	37129	East Texas	Rusk	Woodbine, U. Cret.	.....	39.2	G.B.	.29	41	2.1
13	45033	Slaughter	Hockley	Permian ls.	.....	32.3	B.B.	2.07	48	3.7

PART 2—ANALYTICAL AND COMPUTED DATA

Item	Volume percentages — Fractions — 1-3, inc. (light gasoline)	4-7, inc. (naphtha)	8-12, inc. (kerosine and gas oil**)	13-15, inc. (lubricating oil**)	Residuum	Correlation index, averages of fractions 4-7, inc.	13-15, inc.	Characteristics of residuum % on gasoline-free basis	Specific gravity
	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1	9.7	24.0	24.4	13.9	27.3	25	36	42	0.948
2	15.2	29.6	25.7	12.7	15.1	27	43	28	.958
3	11.9	24.2	23.4	14.0	25.5	27	40	41	.959
4	12.7	20.7	21.2	14.2	29.6	27	37	46	.948
5	12.7	21.2	22.1	13.2	29.5	27	37	46	.945
6	12.9	21.5	22.5	13.3	28.7	27	37	44	.946
7	12.6	21.2	21.2	14.0	29.3	27	37	45	.947
8	15.4	23.7	21.6	12.5	25.7	27	38	43	.948
9	15.7	22.6	21.8	14.2	23.4	28	36	39	.937
10	11.3	20.3	21.1	14.7	29.3	26	36	45	.949
11	17.2	25.0	23.9	15.1	15.1	28	38	26	.943
12	13.2	22.5	23.3	14.8	23.0	27	37	36	.954
13	11.8	20.6	24.0	15.0	27.9	32	51	42	.995

*Colors are designated in accordance with the following: Brownish green, B.G.; greenish black, G.B.; brownish black, B.B.
**Approximate.

Oil production along the Spraberry Trend is from a stratigraphic trap extending northward from the Benedum field in eastern Upton and western Reagan Counties to the Tex Harvey field of Midland County. Northward from the more-or-less contiguous production along the trend, the Spraberry is productive from the Northeast Gail, Dean and Spraberry (Deep) fields in Borden and Dawson Counties (Fig. 1).

Interest in the area and requests for analyses of oils produced along the trend prompted the Bureau of Mines to obtain representative samples from the area for analysis. Approximate locations of the fields from which samples were obtained are shown in Fig. 1.

The oils were all produced from the Spraberry sand and ranged in gravity from 36.8° API for crude oil from Pembrook field to 41.9° API for crude oil from Dean field. All of the oils had uniformly low sulfur content, the maximum being 0.22 wt. % for the Pembrook oil. Pertinent data by the Bureau of Mines Routine Crude-Oil Analysis Method [1] are given in Table 1 for the Spraberry samples and for three additional crude-oil samples from other well-known Texas fields—Snyder, North (Canyon Reef), East Texas (Woodbine), and Slaughter (Permian ls.).

Correlation index curves [2] for all of the Spraberry oils are very similar. The curve for the oil from the Tex Harvey field, which may be considered typical, is shown in com-

Table 2—Routine Analysis of Crude Oil from Tex Harvey Field, Midland County, Texas

Identification

Sample 52019
Tex Harvey field
Upper Spraberry sand
7,010-7,110 ft.
Midland County, Texas

General Characteristics

Sp. gr.	0.833
API Gr.	38.4°
Sulfur, %	0.16
Pour point, °F.	<5
Color	Brownish-green
Viscosity, S.U.S. at 100° F., sec.	45

Distillation, Bureau of Mines Routine Method

Stage 1—Distillation at atmospheric pressure, 733 mm. Hg
First drop, 32° C. (90° F.)

Fraction No.	Cut at— °C.	°F.	%	Sum, %	Sp. gr., 60/60° F.	°API, 60° F.	C.I.	Aniline point, °C.	S.U. visc., 100° F.	Cloud test, °F.
1	50	122	3.3	3.3	0.659	83.2	..	...	..	..
2	75	167	4.1	7.4	.674	78.4	9.4	54.3	..	..
3	100	212	8.0	15.4	.723	64.2	23	50.6	..	..
4	125	257	8.5	23.9	.747	57.9	25	50.8	..	..
5	150	302	6.2	30.1	.764	53.7	26	52.3	..	..
6	175	347	4.8	34.9	.784	49.0	28	53.3	..	..
7	200	392	4.2	39.1	.800	45.4	30	54.4	..	..
8	225	437	4.3	43.4	.817	41.7	32	57.6	..	..
9	250	482	4.5	47.9	.828	39.4	32	61.6	..	..
10	275	527	5.0	52.9	.840	37.0	33	66.4	..	..
Stage 2—Distillation continued at 40 mm. Hg										
11	200	392	2.6	55.5	0.851	34.8	34	74.8	41	15
12	225	437	5.2	60.7	.857	33.6	33	77.2	46	30
13	250	482	3.9	64.6	.868	31.5	35	...	59	45
14	275	527	4.0	68.6	.882	28.9	39	...	90	65
15	300	572	4.6	73.2	.894	26.8	41	...	175	75
Residuum			25.7	98.9	.948	17.8	..	..	..	..

Carbon residue Ramsbottom* of residuum, 4.1%; carbon residue of crude, 1.2%.

Approximate Summary

	%	Sp.gr.	°API	Viscosity
Light gasoline	15.4	0.696	71.8	.....
Total gasoline and naphtha	39.1	0.740	59.7	.....
Kerosine distillate	4.3	.817	41.7	.....
Gas oil	16.2	.843	36.4	.....
Nonviscous lubricating distillate	7.6	.861–.883	32.8–28.8	50–100
Medium lubricating distillate	5.0	.883–.897	28.8–26.3	100–200
Viscous lubricating distillate	1.0	.897–.900	26.3–25.7	Above 200
Residuum	25.7	.948	17.8	.....
Distillation loss	1.1	.....	.....	.....

*Conradson equivalent, 5.6%.

Table 3—Routine Analysis of Crude Oil from Pembrook Field Upton County, Texas

Identification
Sample 52016
Pembrook field
Upper Spraberry sand
Upton County, Texas

General Characteristics

Sp. gr.	0.841
API Gr	36.8°
Sulfur, %	0.22
Pour point ° F	<5
Color	Brownish-green
Viscosity, S.U.S. at 100° F., sec.	45

Distillation, Bureau of Mines Routine Method*

Stage 1—Distillation at atmospheric pressure, 742 mm. Hg
First drop, 31° C. (88° F.)

Fraction No.	Cut at— ° C.	° F.	%	Sum, %	Sp. gr., 60/60° F.	°API, 60° F.	C.I.	Aniline point, ° C.	S.U. visc., 100° F.	Cloud test, ° F.
1	50	122	1.5	1.5)	...	...	..	...	..	..
2	75	167	3.0	4.5)	0.662	82.2	..	51.0	..	..
3	100	212	6.8	11.3	.717	65.9	20	51.8	..	..
4	125	257	7.7	19.0	.745	58.4	21	51.4	..	..
5	150	302	4.2	23.2	.763	54.0	25	52.9	..	..
6	175	347	4.6	27.8	.782	49.5	27	54.0	..	..
7	200	392	3.8	31.6	.800	45.4	30	57.0	..	..
8	225	437	4.3	35.9	.814	42.3	31	59.6	..	..
9	250	482	4.3	40.2	.826	39.8	31	63.8	..	..
10	275	527	5.1	45.3	.836	37.8	31	...	..	..

Stage 2—Distillation continued at 40 mm. Hg

11	200	392	3.0	48.3	0.847	35.6	32	75.2	40	15
12	225	437	4.4	52.7	.852	34.6	31	78.4	46	30
13	250	482	4.9	57.6	.864	32.3	33	...	58	50
14	275	527	4.0	61.6	.871	31.0	33	...	88	65
15	300	572	5.8	67.4	.893	27.0	41	...	165	80
Residuum	..	...	29.3	96.7	.949	17.6	..	...	..	..

Carbon residue Ramsbottom** of residuum, 4.4 percent; carbon residue of crude, 1.5%.

Approximate Summary

	%	Sp.gr.	° API	Viscosity
Light gasoline	11.3	0.695	72.1	.....
Total gasoline and naphtha	31.6	0.742	59.2	.....
Kerosine distillate	4.3	.814	42.3	.....
Gas oil	16.2	.840	37.0	.....
Nonviscous lubricating distillate	8.3	.856–.874	33.8–30.4	50–100
Medium lubricating distillate	6.4	.874–.903	30.4–25.2	100–200
Viscous lubricating distillate	.6	.903–.906	25.2–24.7	Above 200
Residuum	29.3	.949	17.6	.....
Distillation loss	3.3	.....	.....	.....

*Sample contained 0.7% water, removed by preliminary distillation, distillation data on dry basis.
**Conradson equivalent 5.9%.

Table 4—Routine Analysis of Crude Oil from Spraberry (Deep) Field Dawson County, Texas

Identification
Sample 52092
Spraberry (Deep) field
Spraberry (Deep) sand
6,770-6,811 ft.
Dawson County, Texas

General Characteristics

Sp. Gr.	0.839
API Gr.	37.2°
Sulfur, %	0.17
Pour point ° F	<5
Color	Brownish-green
Viscosity, S.U.S. at 100° F., sec.	41

Distillation, Bureau of Mines Routine Method

Stage 1—Distillation at atmospheric pressure, 742 mm. Hg
First drop, 27° C. (81° F.)

Fraction No.	Cut at— ° C.	° F.	%	Sum, %	Sp. gr., 60/60° F.	°API, 60° F.	C.I.	Aniline point, ° C.	S.U. visc., 100° F.	Cloud test, ° F.
1	50	122	2.3	2.3	0.656	84.2	..	...	..	..
2	75	167	3.0	5.3	.669	80.0	7.0	56.7	..	..
3	100	212	6.6	11.9	.719	65.3	21	52.6	..	..
4	125	257	8.8	20.7	.746	58.2	25	52.8	..	..
5	150	302	5.6	26.3	.764	53.7	26	54.7	..	..
6	175	347	5.2	31.5	.784	49.0	28	55.4	..	..
7	200	392	4.6	36.1	.802	44.9	31	55.8	..	..
8	225	437	4.8	40.9	.819	41.3	33	58.0	..	..
9	250	482	4.9	45.8	.831	38.8	33	61.8	..	..
10	275	527	5.5	51.3	.841	36.8	33	62.4	..	..

Stage 2—Distillation continued at 40 mm. Hg

11	200	392	2.7	54.0	0.852	34.6	35	73.8	41	10
12	225	437	5.5	59.5	.859	33.2	34	75.8	46	30
13	250	482	4.6	64.1	.869	31.3	36	...	59	45
14	275	527	4.7	68.8	.886	28.2	40	...	93	65
15	300	572	4.7	73.5	.900	25.7	44	...	185	80
Residuum	...	...	25.5	99.0	.959	16.0	..	...	..	..

Carbon residue Ramsbottom* of residuum, 4.9%; carbon residue of crude, 1.4%.

Approximate Summary

	%	Sp.gr.	° API	Viscosity
Light gasoline	11.9	0.694	72.4	.....
Total gasoline and naphtha	36.1	0.744	58.7	.....
Kerosine distillate	4.8	.819	41.3	.....
Gas oil	17.4	.844	36.2	.....
Nonviscous lubricating distillate	8.6	.862–.887	32.7–28.0	50–100
Medium lubricating distillate	5.0	.887–.902	28.0–25.4	100–200
Viscous lubricating distillate	1.6	.902–.907	25.4–24.5	Above 200
Residuum	25.5	.959	16.0	.....
Distillation loss	1.0	.....	.....	.....

*Conradson equivalent, 6.6%.

parison with similar curves for East Texas and Slaughter crude oils in Fig. 2. The correlation-index curve for crude oil from North Snyder, Scurry County area, is very similar to that for the Tex Harvey oil, and to avoid the confusion caused by coinciding data it is not shown in Fig. 2. The similarity between correlation-index curves for Spraberry, Scurry County Area, and East Texas crude oils might seem to indicate a basic similarity in composition. However, the low aromatic content of the Diesel-fuel portion, its very low pour and freezing points, and somewhat low cetane number indicate a rather large naphthene content. This is borne out by calculations that show a considerably greater portion of naphthene ring in the Diesel-fuel range than in similar material from East Texas, for example.

Straight-run untreated gasolines prepared from crude oils from Tex Harvey and Midkiff are slightly higher in anti-knock quality than those prepared from either the North Snyder, Scurry County Area crude oil or East Texas crude oils. However, the difference may be caused by the narrower boiling range for the sample prepared from the Spraberry oils. Inspection data for gasolines from the Spraberry crude oils are given in Table 5, and similar data for gasolines from the crude oils from North Snyder and East Texas fields were given in a previous report of this series [3].

Diesel fuels prepared from the Tex Harvey and Midkiff crude oils had exceptionally low pour points, and cetane numbers of 43.6 and 45.9 respectively. Complete inspection data for the Diesel fuels are given in Table 6. Diesel fuels of considerably higher cetane number and otherwise meeting the requirements for grades 1-D and 2-D Diesel fuels according to ASTM Designation D975 could be prepared by distillation to a higher end-point product.

In discussing the utilization of these crude oils with respect to preparation of specific products, the same general system is used as in previous articles of this series. The limited data given in the routine analyses preclude exact quantitative data with respect to specific products. However, good approximations of the type of straight-run material that may be prepared are possible.

Aviation base stock: The low correlation-index numbers of the first 4 fractions of the routine analysis indicate no commercial quantities of 91 octane number (with 4.0 ml. TEL/gal.) gasolines could be prepared.

Motor gasoline: This product has been discussed in previous paragraphs. However, it should be noted that the octane numbers given in

Table 5 for the Spraberry gasolines are subject to considerable improvement with proper volatilization to satisfactory vapor pressure and boiling-range-specification requirements.

Kerosine: The low correlation-index numbers indicate that the aromatic content of distillate in the kerosine boiling range is low. This is verified by the aromatic content, 11.4% of the low-end-point Diesel fuel for which data are given in Table 6. These factors, combined with the low sulfur content, imply good burning quality, and indicate approximately 10% kerosine could be prepared from the crude oil.

Diesel fuel: The data in Table 6 indicate approximately 22 to 23% yield of 45 cetane number Diesel fuel. However, the exceptionally low pour point and normally expected increase in cetane number with higher end-point distillate indicate that approximately 30% of 47-50 cetane number Diesel fuel could be prepared. Some treatment for sulfur reduction to meet grade 1-D (ASTM D975) specifications would be necessary.

Fuel oil: The percentage-yield figures given in the preceding discussion for Diesel fuel are applicable to fuel oil.

Jet-engine fuel: The analyses discussed in this report without exception indicate that the Spraberry oils should be a good source of jet-engine fuels, meeting either JP-3 or JP-4 specifications. Insufficient data are available to determine exact yields. However, the 515° F. end-point Diesel fuel prepared from the Tex Harvey crude oil had a satisfactory freezing point of —76° F., a critical and very often limiting specification requirement. A minimum yield of 22% grade JP-3 or JP-4 is indicated.

Lubricating oil: Approximately 6 to 7% of medium viscous lubricating-oil stock is available from the Spraberry oils. Considerable treatment for dewaxing would be necessary.

Asphalt: The Spraberry oils contain a uniformly low asphalt content of 3 to 7%. These yields were obtained from the relationship explained in a previous article of this series [1] that the asphalt content of crude oil is approximately 4.9 times the wt. % carbon residue of the crude oil.

References

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(2) Smith, H. M., "Correlation Index to Aid in Interpreting Crude Oil Analyses," *Bur. of Mines Technical Paper* 610 (1940).

(3) Smith, N.A.C., Smith, H. M., and McKinney, C. M., "Refining Properties of New Crudes," Part 2—Characteristics of Crude Oils from the Scurry County, Texas, Area. PETROLEUM PROCESSING, 5, 731, (1950).

(4) Smith, N.A.C., Smith, H. M., and McKinney, C. M., "Refining Properties of New Crudes," Part 1—Significance and Interpretations of Bureau of Mines Routine Crude-Oil Analysis, PETROLEUM PROCESSING, 5, 609, (1950).

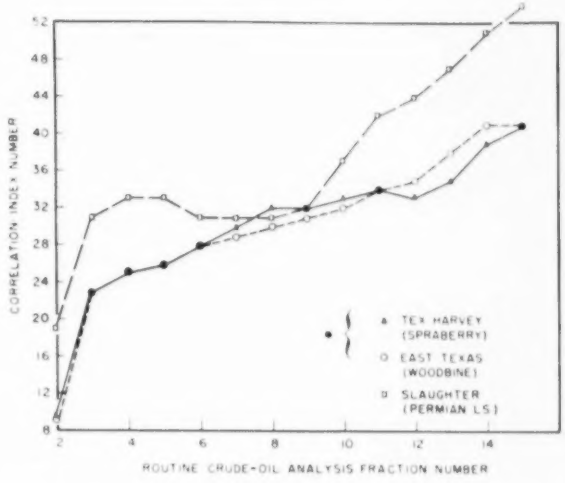

CORRELATION INDEX NUMBER
ROUTINE CRUDE-OIL ANALYSIS FRACTION NUMBER
A TEX HARVEY (SPRABERRY)
O EAST TEXAS (WOODBINE)
□ SLAUGHTER (PERMIAN LS)

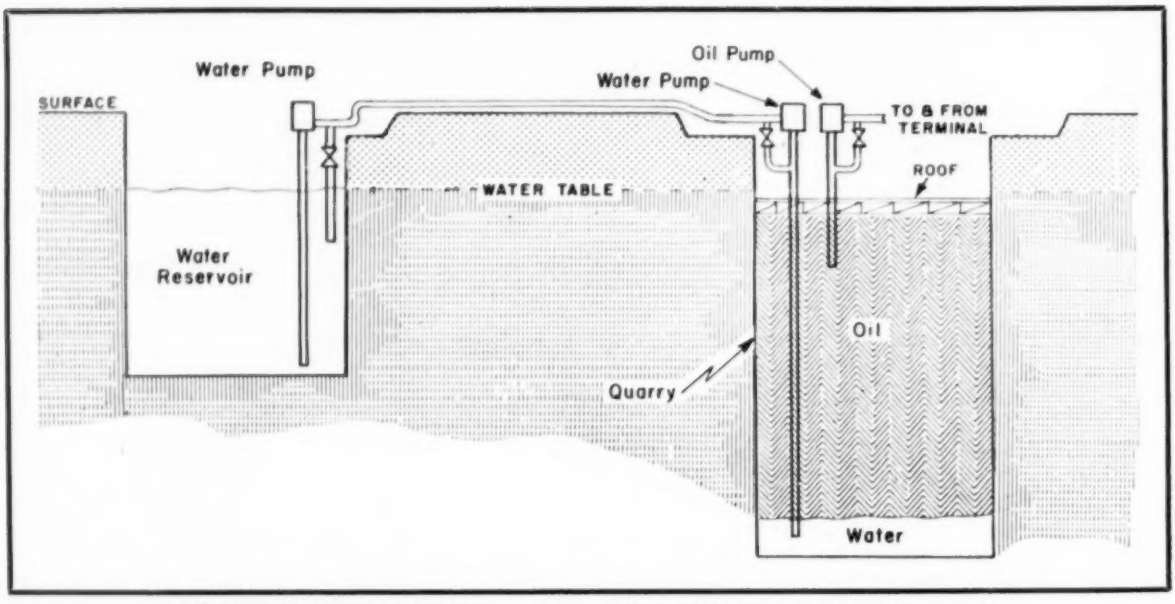
FIG. 2—Correlation index curves for Tex Harvey, East Texas and Slaughter crude oils

Table 5—Properties of Gasolines from Crude Oils from Tex Harvey and Midkiff Fields, Spraberry Area

	Tex Harvey	Midkiff
Yield, vol.-% of crude	32.8	30.1
Gravity, specific	0.742	0.746
Gravity, °API	59.2	58.2
Reid vapor pressure, lb.	3.3	3.7
Sulfur, wt.-%	0.006	0.005
Corrosion, Cu strip 3 hr. at 210° F.	Neg.	Neg.
Distillation, ASTM D86, Temp., °F. at % evap.:		
I.B.P.	162	146
5	175	172
10	182	182
20	193	193
30	204	204
40	217	216
50	228	227
60	241	242
70	255	262
80	276	288
90	302	318
95	318	334
E.P.	350	362
Octane No. ASTM D357 (Motor):		
Clear	62.2	62.0
1.5 ml. TEL/gal.	77.7	77.1
3.0 ml. TEL/gal.	82.7	82.3

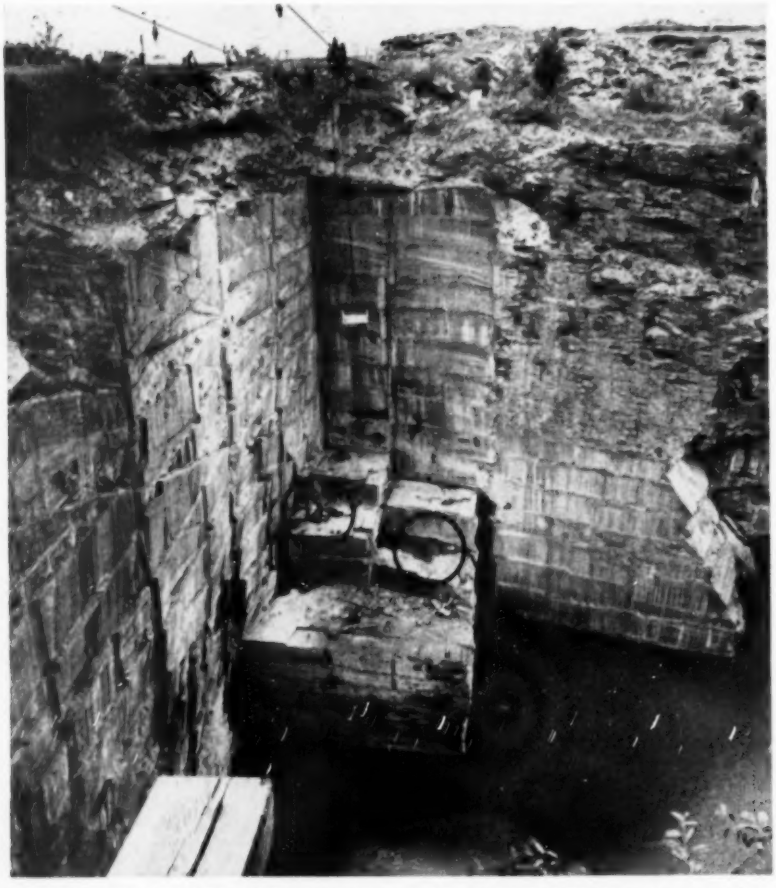
Table 6—Properties of Diesel Fuels from Crude Oils from Tex Harvey and Midkiff Fields, Spraberry Area

	Tex Harvey	Midkiff
Yield, vol. % of crude	22.8	21.9
Gravity, specific	0.819	0.818
Gravity, °API	41.3	41.5
Sulfur, wt. %	0.112	0.154
Corrosion, Cu strip 3 hr. at 210° F.	Neg.	Neg.
Aniline point, °F.	141.8	144.3
Bromine No.	2.7	2.4
Hydrocarbon analysis, ASTM D875		
Aromatics, vol. %	11.4	11.4
Olefins, vol. %	2.9	2.6
Flash point, ASTM D93, °F.	124	120
Cloud point, ASTM D97, °F.	<—60	<—60
Pour point, ASTM D97, °F.	<—60	<—60
Viscosity, ASTM D445, cs. at 100° F.	1.53	1.56
Cetane No., ASTM D613	43.6	45.9
Distillation, ASTM D158, Temp., °F. at % evap.		
I.B.P.	328	325
5	345	343
10	354	350
20	363	365
30	378	382
40	395	400
50	413	418
60	432	436
70	450	452
80	470	472
90	490	494
95	503	508
E.P.	515	522



PROPOSED INSTALLATION for underground oil storage, showing pontoon-type roof

Old Quarries for Oil Storage



ABANDONED SLATE PIT, typical of proposed "tanks." Tremendous depth is emphasized by size of workmen—see circles

By V. B. GUTHRIE, Editor

THAT eastern Pennsylvania refiner who occasionally loses a ball in an abandoned limestone quarry adjacent to the fairway of his favorite golf course may be now studying this excavation from another point of view than merely as a golfing hazard. In fact, he may well be looking closely at other old stone pits in the general area of his plant.

Studies of the possible wide use by refiners of abandoned stone quarries for seasonal or long-term storage of products has followed the announcement of Esso Standard Oil Co.'s plan to make a reservoir for heating oils out of an old slate quarry about 60 miles from its Bayway, N. J. refinery. Esso's program would eventually link these pits into the plant's storage system, providing for greater use of steel tanks in terminals convenient to markets.

The Esso plan is the first in this country for using this type of underground reservoir. Previous proposals have been made for storing oil in cavities in shaft mines and in salt domes.

Scattered over Pennsylvania, New York, Ohio, Illinois, Missouri, Minnesota and other states are many abandoned quarries and pits from which slate, limestone, sandstone, marble, granite and other kinds of stone were at one time excavated. The number or location of most of them has not been recorded, but there are many hundreds, possibly thousands, of them. In most cases they are part-

ly filled with water. Single pits in some instances could provide liquid storage of up to 10,000,000 barrels.

Pits in formations of slate, limestone and other stones are considered practicable for storing oil, other conditions being suitable. Open mines of iron, copper and some other metals are not practicable because of likelihood of contamination of the oil by sulfur or other compounds.

A general condition required, if the rock formation is favorable to avoid contamination, is that the pit be deep and narrow, with reasonably straight walls, to simplify the problem of roofing. The depth of the pit should be studied in connection with the level of the water in it, on which the oil would ride, if the Esso plan were followed. A 100-ft. deep quarry might provide half or less of that depth for the actual storage of material.

The Esso method calls for a second pit in the vicinity for water storage, since the level of the stored oil is maintained by pumping in or withdrawing water, as the oil is respectively withdrawn or added. The level of the surrounding water table is important. The method being installed by Esso provides that the level of the oil stored in the pit be held below the level of the water table. Thus the pressure of the water level on the walls of the pit is greater than that of the oil, which prevents oil seepage into the ground nearby.

Geographically, the terrain should be suitable for connecting refinery and storage pit by pipeline and if possible connecting the pit and terminal tankage near marketing centers. Economic conditions, including volume of storage contemplated, would govern the distance between refinery and the quarry storage. It is felt that, where a pipeline has to be built, distance is not the most important factor to be considered.

Initial savings with the underground reservoirs will be substantial, Esso Standard engineers believe. They estimate the pits, including roofing, will cost from 25c to $1 a barrel, as compared with $2 at present for steel.

In emergencies, the savings in steel itself might be important. Aside from installation costs, savings in maintenance are seen through doing away with the need for tank painting, keeping up dikes and firewalls, and other fire protection facilities required where tanks are located at refineries or in populated areas.

At present this quarry type of underground storage is likely to be considered more as an industry or a government defense project, because of the volume involved and the fact that it is seasonal or long-term storage, rather than as an undertaking for an individual refiner. It is thought that a group of refiners in one area, marketing the same kinds of volume products, could combine in a quarry storage operation, to their mutual benefit.

Some people expect to see this natural underground storage adopted by the government as a part of the defense program, where large volumes of material would be held against emergency needs. Aside from savings in steels, its advantages here would be in maintaining supplies at some distance from such strategic bombing targets as refineries, and the greater ease of camouflaging the pit storage. Maintenance costs would be lower than steel tankage.

The initial project of Esso Standard is for the seasonal storage of heating oils in a quarry. Company engineers now see no reason why gasoline, naphthas, kerosine and crude oil cannot be handled in this form of storage.

With heavy fuel oils, emulsions resulting from contact with water, might present a problem which would make the operation uneconomic because of filtering and treating required when the material was removed.

With heating oils, Esso engineers contemplate no additional filtering when the product is withdrawn, except perhaps with the first material pulled out.

With gasoline, a very material advantage of the underground storage is seen in the reduction or elimination entirely, of evaporation losses, due to the lower temperatures at which the material would be held in the ground.

The principal engineering problem in adapting the abandoned quarries for oil storage, is in roofing them, Esso engineers say. Deep, narrow pits with straight walls simplify this problem. Roofs are considered desirable to protect the oil from direct sunlight, dust and animal life.

Two types of roof are being studied: either a pontoon roof made up of sections designed to fit the irregular contour of the quarry, or a suspension roof consisting of steel plate hung on a network of cables spanning the quarry. The floating deck roof presents some difficulties because of the irregular walls. It is believed, however, that with the method of replacing oil, as it is withdrawn from the pit storage, with water, the roof movement would not be more than 6 in. This would simplify the problem of providing a skirt for the roof which would maintain contact between the roof and the pit walls.

It is not thought necessary to provide a watertight roof for the pit storage contemplated by Esso Standard, since the stored oil would ride on water in the pit. Water draining through the roof would move through the oil to the water level. In some geographical areas, designing the roof to carry a heavy snowload without collapsing would be more of a factor.

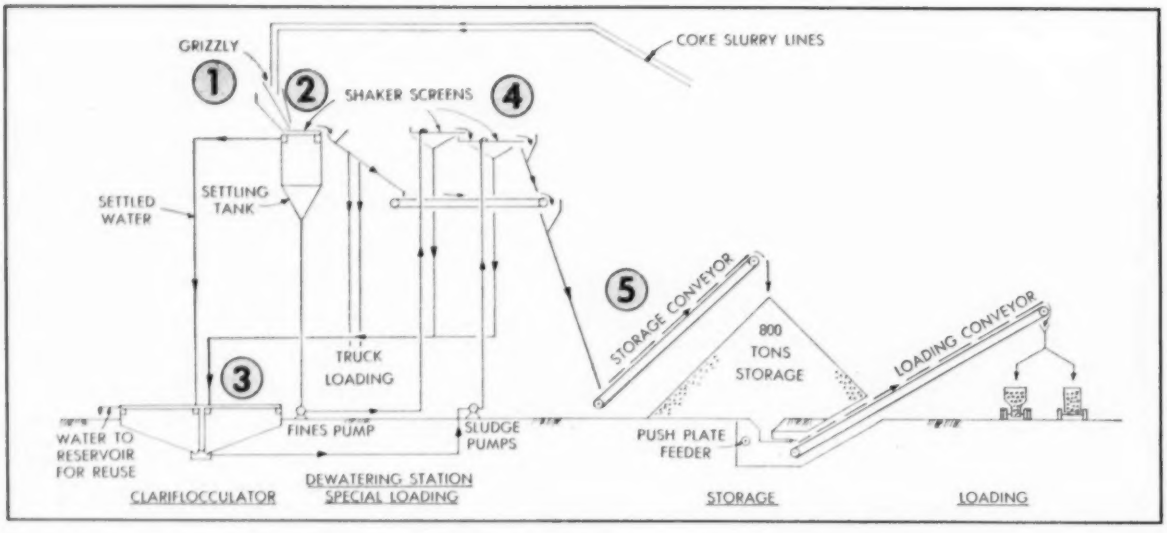
Esso Standard Oil Co. has for some time been investigating the possibilities of various types of underground oil reservoirs adjacent to the northeast seaboard states, where the greatest seasonal storage needs exist. The slate quarries in Pennsylvania were selected by virtue of location, size, convenience of existing facilities and the fact that the inert slate material does not contaminate the quality of heating oil.

The company has taken options on 11 slate quarries in the Pen Argyl section near Bethlehem, which have a total potential capacity of 13,000,000 barrels of heating oil, equivalent to the seasonal heating requirements of 325,000 average homes. The pits range from 100 to 300 ft. deep, 200 to 500 ft. long, and 140 to 270 ft. wide. Except for suitable protective roofing and other necessary facilities, these pits can be converted to large storage reservoirs with relatively minor engineering.

Initially, Esso is considerering the operation of only one pit in this area, which has a capacity of 3,000,000 bbls. and has existing pipeline facilities nearby. The mine is 270 ft. deep, 350 ft. wide and 250 ft. long. Capacity of the lines will limit the storage to 1,500,000 bbls. It will take about a year to adapt the pit to storage, at an estimated cost of $1,000,000.

The storage operation will be carried out by removing water from the bottom of the pit as oil is pumped in at the surface. To insure that the water pressure on the walls of the pit is always greater than the pressure of the oil, the oil level will be held below the level of the surrounding water table. Any leakage would then be in the direction of water into the pit. Water seepage would be periodically pumped from the pit as necessary to keep the oil level below the water level.

When oil is removed during the heating season, the procedure will be reversed and water pumped into the pit below the level of the oil. This requires the use of a second quarry which will supply water to displace the oil and act as a safeguard against oil-bearing water being pumped into natural streams, and carrying a pollution problem. As further precautions, a series of small wells will be drilled in areas adjacent to each pit, to allow observation of the water level at all times. Water samples from the wells will be tested periodically for the presence of oil.



SCHEMATIC DIAGRAM of General Petroleum's coke handling facilities

CONTINUOUS WATER REMOVAL in this unit yields better coke product than former method of draining from a coke-water slurry stockpile

THE FIRST "SPLIT" of water from coke occurs in this chute containing a metal-bar "grizzly" for separation of the larger chunks

MECHANIZED DEWATERING FOR

Drier, Cleaner Petroleum Coke

By FRANK BREESE
West Coast Editor

General Petroleum Corp. thought up a good way to get the water out of freshly-made coke. As a result, it's doing the job more efficiently than with the old system; so operating problems have been eliminated, the product is cleaner, and the customer is happy.

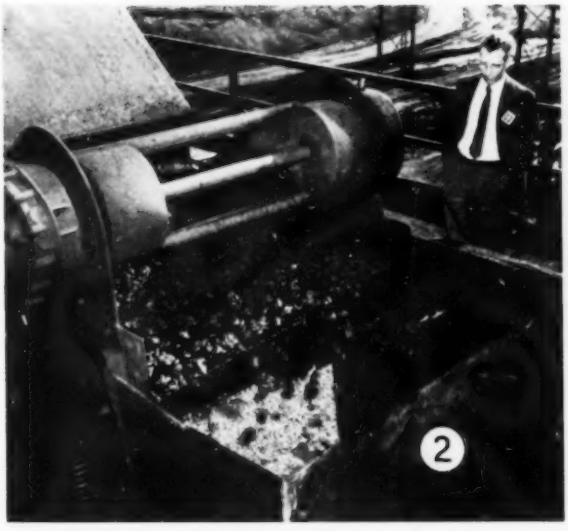
The old system was simply that of dumping the coke-water slurry into a stockpile and letting the water drain off.

By the new method, coke and coke fines are separated systematically from water through a series of steps. Principal equipment includes a metal-bar screen (called "grizzly"), vibrating screens, settling tank and a clariflocculator.

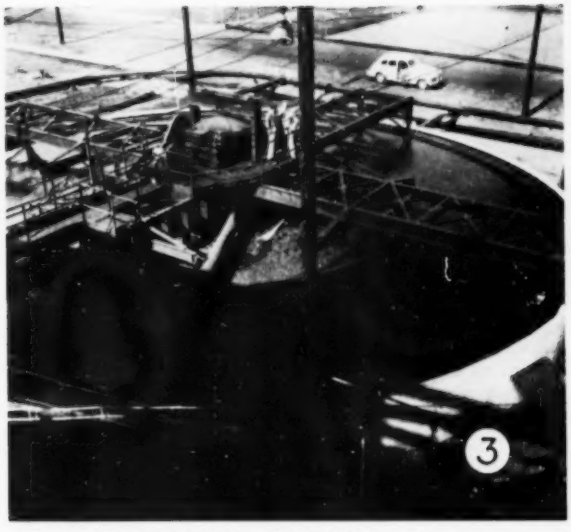
End products of this dewatering system are clean coke with a low water content for commercial use and de-coked water fit for re-use in the coking unit. Water content runs 5% to 15% of total volume, an improvement over the performance of the initial dewatering process, which left a water content of about 20% by weight.

This is believed to be an original method for dewatering coke, and the use of the clariflocculator is a unique feature.

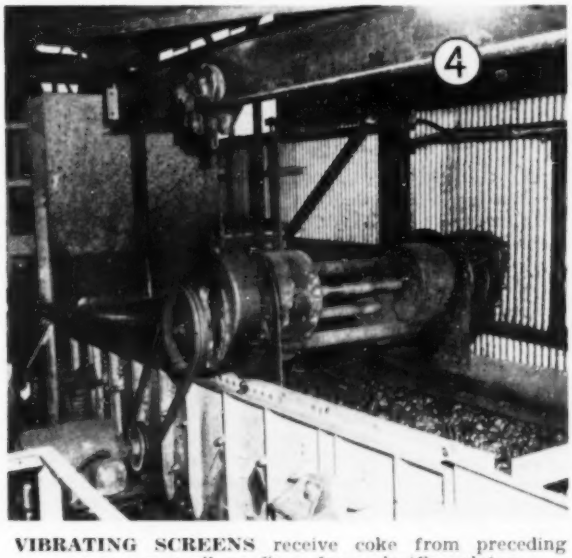
After World War II, GP went into the coke-producing business on



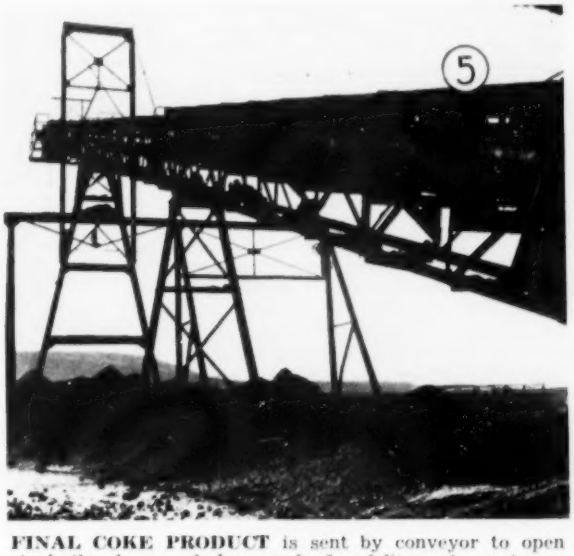
WATER BOUNCES OUT of coke by vigorous vibration of shaker screens just below the grizzly chute



STANDARD CLARIFLOCCULATOR, in this unusual application, removes the fines and returns clear water to coking unit for re-use



VIBRATING SCREENS receive coke from preceding screens as well as fines from clariflocculator



FINAL COKE PRODUCT is sent by conveyor to open stockpile clean and dry, ready for delivery to customer

a big scale and today operates the world's largest delayed re-cycle coker, located at the Torrance, Calif. refinery. Production averages over 1000 tons a day (three 4/10 drums a day, with each drum averaging 310 tons), and the entire output is taken by Great Lakes Carbon Corp. This is an important operation because it takes care of a substantial quantity of bottom-barrel cuts which have a recurring habit of developing into a manufacturer's headache.

Going back to 1946, the old method of handling the coke was to discharge the coke-water slurry from a 12-in. elevated pipe line onto a small, concrete splash pad in the center of an area surrounded by a 3-ft. wire fence.

The large coke was retained by the fence, and the water ran off to a 600,000-gal. settling basin from which it overflowed to a 4,000,000-gal. storage basin. Eventually, substantial coke dikes were built up and the water was retained long enough to settle out some of the fine coke. However, a single decoking discharged 1,500,000 gal. of water and coke which made it impossible to provide more than a brief settling time. Consequently, much coke was carried out with the effluent water.

Attempts to close up the dikes and build a 5 to 6-ft. water level invariably resulted in washouts. To remedy this situation, dikes were heaped still higher, and overflow pipes were laid in the dikes. Interior standpipes permitted maintaining a water level inside.

Two such basins were formed, and the slurry was fed into each on alternate days. Thus a bulldozer could work in the inactive basin removing the previous day's coke while the current output was being discharged into the adjoining basin. A crane loaded shipments from the edge of the basins.

This system worked but it was expensive because of the great amount of work involved. There were other objections, too: (1) Large coke was broken down by the bulldozer, degrading the product. (2) The abrasive action of coke dust was hard on equipment. (3) Admixture of dirt from scraping increased the ash content and resulted in loss of coke. (4) The drying was inadequate. (5) Overflow water carried enough

fines with it to make it necessary to clean the settling basins annually. (6) It was necessary to tie up an inventory of some 30,000 tons of coke to maintain the dikes around the settling basins.

GP engineers devised a system based on a series of five separation actions, or "splits". Today the coke is shaken like popcorn to wring the water out before it is piled in the storage area. And the water itself is systematically processed so that it flows clean to reservoirs for re-use. The new system has eliminated the objections of the old.

There are seven steps in the procedure:

1—After a drum of coke is taken off stream and cooled, the coke is cut out with high-pressure water jets and then dumped in a toothed roll crusher where it is ground into chunks under 5-in. in size. It is washed into a suction pit and pumped away as water slurry through stainless steel pipes 1750 ft. to the separation unit. There it is discharged into a "grizzly".

2—The first separation occurs in the grizzly, a sturdy device constructed of lateral metal bars, placed about ¼ in. apart. The bars, or plates, are turned edgewise, with the narrow width at top and bottom and the 2-in. wide side vertical. Pieces less than ¼ in. size are separated from the larger chunks; and slurry water falls through the grizzly into the surge tank underneath the grizzly. This step removes the coarse coke and most of the water.

3—The coke tumbles through the grizzly chute to the first of three sets of vibrating screens. The top screen has a 1-in. mesh and the bottom screen ¼-in. mesh; both are 5 x 8 ft. in size. These vibrating screens shake the water out of the coke, which is jarred forward to a chute and passed to a belt conveyor.

At this point, the coke which is bigger than ¼-in. in size can be diverted from the conveyor for truck loading. Two chutes are for the two sizes: over ¼-in. but less than 1-in. and over 1-in.

4—Meanwhile, the slurry water and fine coke have passed through the grizzly into the settling tank below. Water shaken from coke by the screens also drops into it. The tank contains fines which the water has carried through.

From here the fines may go in two directions. Some are pumped from the bottom of the settling tank to the second screen for further dehydrating by vibration. Or they may be carried out of the surge tank by overflow. The fines-containing water spills over the weir and is carried to the nearby clariflocculator.

5—The clariflocculator removes the fines from the water, sends them back into the vibrating screen system for more shaking and keeps discharging a stream of clarified coke water to a nearby reservoir for eventual re-use.

A standard Dorr clariflocculator is used. It is composed of a 40-ft. diameter compartment suspended in the center of a 75-ft. concrete tank. The bottom of the tank slopes from a depth of 10-ft. at the outside to 17-ft. at the center. The water and coke fines enter the top center of the 40-ft. diamenter compartment, and the dispersed phase is flocculated by the mild agitation of paddles which revolve at about one rpm.

The water flows through the bottom of the 40-ft. section into the outer clarifying section and overflows the notched weir of the outlet launder, located near the periphery of the 75-ft. tank. A sludge rake which makes one revolution in about 15 minutes brings settled fines from all parts of the bottom to the center of the cone. Two Gould centrifugal pumps with open-type impellers return the sludge to the vibrating screens.

6—The second set of vibrating screens receives fines and water from the bottom of the settling tank only. More water is shaken out. Coke from this screen passes onto the third set of screens (which also receives the fines from the bottom of the clariflocculator—deposited on top of the coke from the second screen). The water filters through the screens and flows to the clariflocculator carrying fines in it.

The vibrating screens are called Robins "Eliptex Dewaterizers." Each assembly is 4 x 16 ft. and is double-decked with the top screen made of 7/16-in. opening square mesh wire cloth, and the bottom screen of 0.50 opening. Vibration results from rotation of eccentric weights on two shafts running 1200 rpm by a belt drive from a 15 h.p. motor. The screens move in a vertical plane along their major axis in an elliptical path inclined 45° from the horizontal, with the major axis of the ellipse 7/16 in. long and the minor axis 1/16 in. long.

The rotating screen gives the coke particles a hopping, zig-zag movement. As they tumble throughout the length of the screen, the water is bounced out of the coke. An elliptical movement on a vibrating screeen is just the thing for dewatering a solid, commented a GP engineer.

7—The third shaker bed receives coke from the second and also the fines pumped from the clarifocculator. A bed formed by the next coarsest coke (from the second set of screens) helps hold the fine particles of coke so that they will move on to the conveyor. The water and fines which filter through are carried to the clariflocculator. In effect, there is a re-cycling of the fines.

From here the coke passes to a conveyor which discharges it in the open stockpile area.

At first, the installation consisted of two assemblies of vibrating screens and the clariflocculator. Later, GP added the grizzly, settling tank and a third shaker-screen assembly which are employed for the first separation and which have improved the degree of efficiency.

Product from the stockpile is loaded on trucks or gondolas by a loading conveyor, or by crane; and the trucks are weighed to determine the amount of coke.

The dewatering system has to handle coke-water slurry at the rate of 3,000 gpm.

In terms of b/d, it is estimated that the shaker screens handle 93,500 b/d of slurry, of which some 86,130 b/d is water and 7,350 b/d, coke. It is estimated that about 800 b/d of water remains in the coke.

Because it is impossible to cut the coke at a uniform rate, the material pumped varies from water alone to a thick slurry, and the coke in suspension from a soft, fine material to a hard, coarse aggregate as the cutting progresses from the top of the drum to the bottom.

When the operation got under way, various operating problems arose. They included: overloading the system with excessive discharges of slurry water; mesh leakage; stoppage of the sludge rakes in the clariflocculator, and maintenance. In solving them, GP's engineers have developed and refined the process so that today it is a smooth, relatively problem-free operation.

Because the installation is simple and automatic, little man-power is required. One man on each shift attends to routine tasks such as starting and stopping of screens and conveyors, greasing of shafts and idlers, shoveling of dropped coke back to conveyors, etc.

The system was developed by A. K. Brumbaugh, GP engineering department, and the firm of Migula and Sutton, which purveyed the dewaterizing equipment. At that time Richard E. Lauterbach was a refinery engineer in charge of thermal cracking. Since then, he was named manager of GP's 35,000 b/d refinery at Ferndale, Wash., and now manager of the manufacturing dept.

Picture Credit

Photographs accompanying this article, courtesy General Petroleum Corp., made by William Fox.

Table 1—ASTM Requirements for Aviation Gasolines

(Condensed from Official Specification D 910—50 T)

Grade	80-87	91-98	100-130	New Grade 108-135	115-145
Octane No. Min.					
Lean rating	80	91	100	isooctane plus 0.22 ml. TEL gal.	isooctane plus 0.47 ml. TEL gal.
Rich rating	87	98	isooctane plus 1.28 ml. TEL gal.	isooctane plus 1.68 ml. TEL gal.	isooctane plus 2.8 ml. TEL gal.
Color	red	blue	green	brown	purple
TEL max., ml. per gal...	0.5	2.0	3.0	3.0	4.6
Net heat of combust. min., Btu/lb.	18,700	18,700	18,700	18,800	18,800

Requirements for All Grades

Dist. Temperature °F	
10% evap., max.	158
50% evap., max.	221
90% evap., min.	212
90% evap., max.	257
Final boiling point, max. °F	338
Sum of 10 and 50% evap., temp., min., °F.	307
Distillation recovery, min., %	97
Distillation residue, max., %	1.5
Distillation loss, max., %	1.5
Acidity of distillation residue	shall not be acid
Vapor pressure, max., lb.	7.0
Corrosion (copper strip)	no worse than No. 1 comparison standard
Gum by copper dish, max., mg. per 100 ml.	5
Potential gum (5 hr. aging gum) max., mg. per 100 ml.	6
Visible lead precipitate, max. mg. per 100 ml.	3
Sulfur, max., %	0.05
Freezing point, max., °F	minus 76
Water tolerance	volume change not to exceed ± 2 ml.
Permissible gum inhibitors, max., lb. per 1000 bbl. (42 gal.)	4.2

Standard For 5th Avgas Grade Approved

Referred to ASTM by D-2, new 108-135 rating is same blend as 115-145 but uses 3 cc Tel

AN official yardstick for the 108-135 grade of commercial aviation gasoline was approved by Committee D-2 on Petroleum Products and Lubricants of the American Society for Testing Materials, at the ASTM annual meeting in Atlantic City, June 29-July 3. The new grade, 108-135, makes a total of five for both military and commercial use for which Committee D-2 has set up quality standards, and which some refiners will have to handle. See Table 1.

However, refiners will not be able to supply the new fuel in any considerable volume while the current general shortage of aviation gasoline lasts. The new fuel is the same blend of alkylate and high grade gasoline stocks as the present 115-145 military grade. Chief difference is that the 108-135 fuel will contain no more than 3 ml. of tetraethyl lead per gallon, while the specifications for the 115-145 grade permit a maximum of 4.6 ml. TEL. Approval of the Petroleum Administration for Defense is required for refiners to supply the new 108-135 fuel.

In the development and operation of the engines used some of the newer planes, it was learned that as much power could be secured from the 115-145 fuel with less TEL than the maximum of 4.6 ml. called for in its specification. For the airlines, this means more hours of service without overhauls and changing sparkplugs. The largest piston airplane engine has 56 sparkplugs. The saving in TEL is important to refiners also. So the new 108-135 "Spec" was drawn with 3 ml. of TEL maximum, looking forward to the day when military requirements won't take all the high quality aviation gasoline, and supplies will be more available to the commercial lines.

The new standard approved by Committee D-2 and referred to the parent ASTM is now subject to unanimous approval by letter ballot of the full D-2 membership, when it will become an official ASTM standard. Specifications for the new 108-135 grade were first proposed two years ago, but agreement then couldn't be had on an identifying color. This year the committee agreed on brown for color. Sources of supply for an acceptable color dye are available.

At airports the grades of avgas dispensed are identified entirely by color. The refiner blends in the color before he ships the material from his plant. The grade is checked by Air Force-Navy Aeronautical color standards before the planes tanks are filled.

Viscosity Standards Change

The adoption by the National Bureau of Standards of a new value for the kinematic viscosity of water[1] made necessary changes in the tables for calculating Viscosity Index as well as in ASTM standard test methods having to do with kinematic viscosity. These changes were adopted by Committee D-2.

STP 43, an amplified VI table based on kinematic viscosities, which supplemented ASTM standard test method D-567, Method of Calculating Viscosity Index, had to be revised in line with the new NBS value for kinematic viscosity of water. Research Division VII of Committee D-2 has revised and expanded these tables and they are now available in ASTM STP 43A.

ASTM is also planning to bring out late this year, a set of even more amplified VI tables comparable to the four series of tables prepared by Standard Oil Development Co., which were made available for industry use. The SOD tables became obsolete with the change in the value for the kinematic viscosity of water.

The changed ASTM standard tests are D-445, Method Test for Kinematic Viscosity; D-446, Conversion of Kinematic Viscosity to Saybolt Universal Viscosity; D-567 Method of Calculating Viscosity Index; D-666, Conversion of Kinematic Viscosity to Saybolt Furol Viscosity.

(1) "Four Viscosity Standards Changed," PETROLEUM PROCESSING, April 1953, pg. 525.

TO HELP YOU DESIGN FRACTIONATORS

Distillation of Ternary Mixtures

Complete Columns—Partially Distributed Components

No. 6 in a Series

By ROBERT R. WHITE
Dept. of Chemical and Metallurgical Engrg.
University of Michigan

THE previous discussion of the fractionation of ternary mixtures in complete columns dealt with separations specified by the concentration of the least volatile component in the distillate and the concentration of the most volatile component in the bottoms, so that both products always contained all of the components and at the minimum reflux ratio the zone of infinite stages contained a ternary mixture.

Specification of x_{aB} and x_{aD}

As might be expected from the previous consideration of rectifying and stripping columns, other methods of specifying the separation desired may lead to the development of binary as well as ternary zones of constant composition and infinite stages in the fractionation of ternary mixtures. A typical example is furnished by the specification of the concentration of the most volatile component in both the distillate and bottom products.

As indicated in Fig. 1, where one of the specification lines is not widely separated from the feed point F, the relationships between reflux ratio, the number of stages, feed location, and product composition follow the pattern previously discussed in detail for the specification of x_{aB} and x_{cD}. Thus, Fig. 1 is similar in all respects to Figs. 1-12, Article No. 5.[1]

The value of x_{aD} may be so specified that the equilibrium tie line through the feed point F intersects the binary base a-b at the locus x_{aD} as shown by the point D_R in Fig. 2. The distillate product, D_R, from a reboiled rectifying column with infinite stages is a binary mixture of components a and b and fractionation to the bottom product, B_R, takes place through a binary zone of constant composition, $L_\infty V_\infty$, this zone of infinite stages occurring in the middle of the column. This zone is located by the[2] methods discussed for rectifying columns (Figs. 7 and 8, Article No. 2). The value of L/V equals the distance ratios $D_R V_S / D_R B_R = D_R V_\infty / D_R L_\infty = L/V$.

As the value of x_{aD} is increased still further, the composition of the distillate product produced from columns having an infinite number of stages in the rectifying section is determined by the intersection of the distillate specification line with the binary base, a-b, as indicated in Figs. 3, 4 and 5. Furthermore, the same distillate product can be produced from columns having an infinite number of stages in the rectifying section over a range of values of L/V as indicated by the vertical line $B_R B'_R$ in Fig. 5.

The stage-to-stage calculations for the maximum value of L/V for a column with infinite stages in the rectifying section are illustrated in Fig. 3 and with the bottom product represented by the point B_R. Fractionation proceeds from the bottom product to the binary zone of infinite stages $L_\infty V_\infty$ and from there up the binary system a-b to the distillate product. The composition of the binary zone of infinite stages is located by extrapolating the tie line BV_S to the binary base $a\,b$ [$x_c = 0$] and using the value $L/V = OV_s/OB_R$ to calculate L_∞ using the equation

$$x_i = \frac{(1 - L/V)\, x_{iD}}{\alpha_i K_r - L/V} \qquad (1)$$

as discussed previously (Fig. 8, Equation 22, Article No. 2).[2]

The value of the maximum reflux ratio is

$$L/V = DV_\infty / DL_\infty$$

At a somewhat lower value of L/V, the binary zone of infinite stages is richer in component a as indicated in Fig. 4 and fractionation from the top of the column proceeds from the binary zone to point L_f on the straight parallel line path to the tile line LV which extrapolates to the point D and whose line segments $DV/DL = L/V$. The coordinates of L are conveniently found from Equation 1 since for the absent component, in this case, c,

$$x_{c\,L} = \frac{(1 - L/V)\, x_{cD}}{\alpha_c K_r - L/V} \qquad (1a)$$

But since x_{cL} is a real positive number and x_{cD} is zero, $\alpha_c K_r - L/V$ must equal zero and the solution to Equation 1 must be $K_r = \frac{1}{\alpha_c} \frac{L}{V}$. When this value is substituted in Equation 1 for each of the components the values of x_{iL} result.

The calculations at the feed plate must match according to the diagram of Fig. 4. By a material balance, the sum of vapor rising from the feed stage, V_f, and the bottom product, B, must equal the sum of the feed, F, and the liquid entering the feed stage L_{f-1}. Thus, the point representing $(F + L_{f-1})$ is the intersection of the lines $V_f B$ and FL_{f-1}. If the feed is a saturated liquid, the quantity of vapor entering the feed stage, V_{f-1}, is equal to the quantity of vapor leaving the feed stage, V_f, the difference between the two being represented by $\pm\infty$ along the line $V_f V_{f-1}$. This difference must also equal the difference between $(F + L_{f-1})$ and L_f so that the point V_{f-1} must lie on the intersection of the line BL_f and the line through V_f which is parallel to the line $L_f(F + L_{f-1})$.

The plate to plate calculations are then continued through a finite number of stripping stages to the bottom product. The point L_f is most conveniently located at a given value of L/V in rectifying section, and consequently $\bar{L}/\bar{V}$ in the stripping section, by finding the

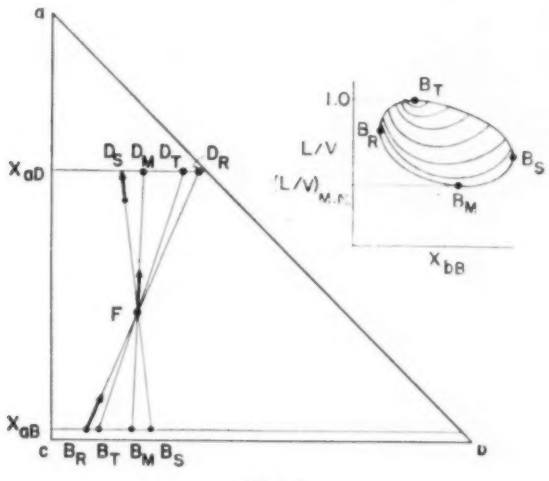


FIG. 1

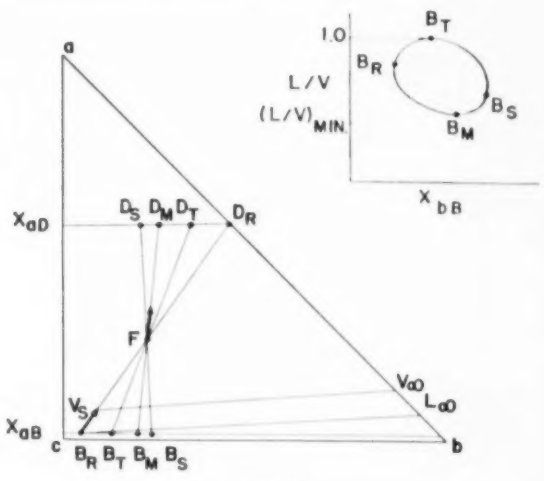


FIG. 2

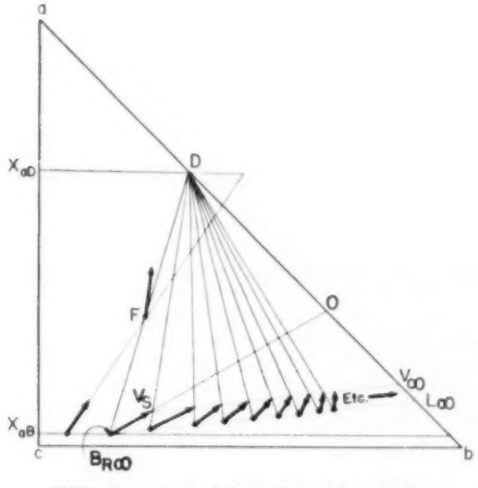


FIG. 3—Reboiled Rectifier (Max. L/V)

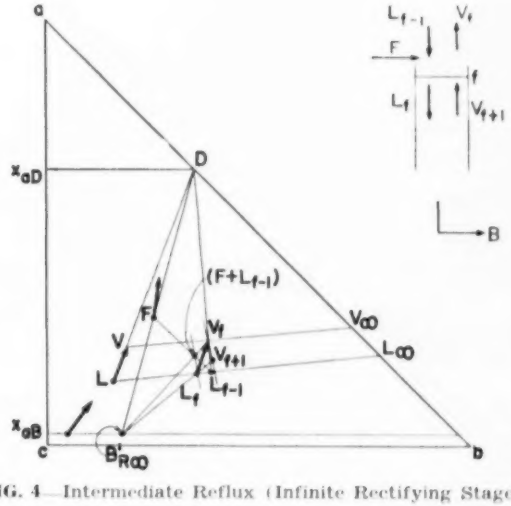


FIG. 4—Intermediate Reflux (Infinite Rectifying Stages)

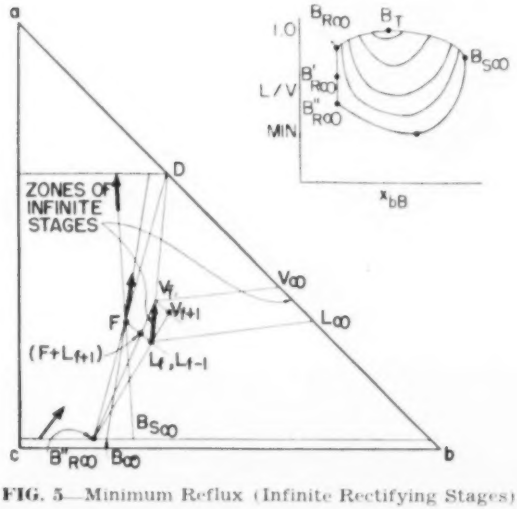


FIG. 5—Minimum Reflux (Infinite Rectifying Stages)

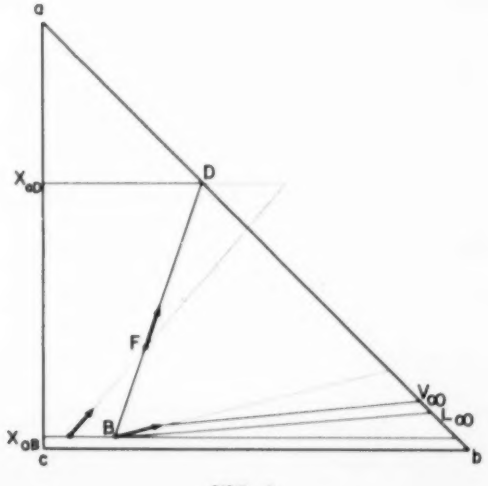


FIG. 6

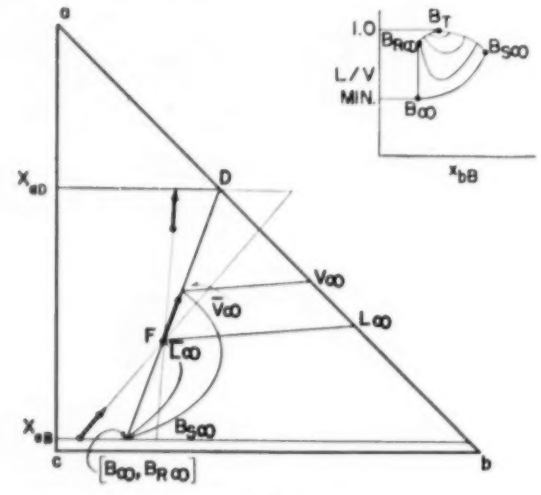


FIG. 7

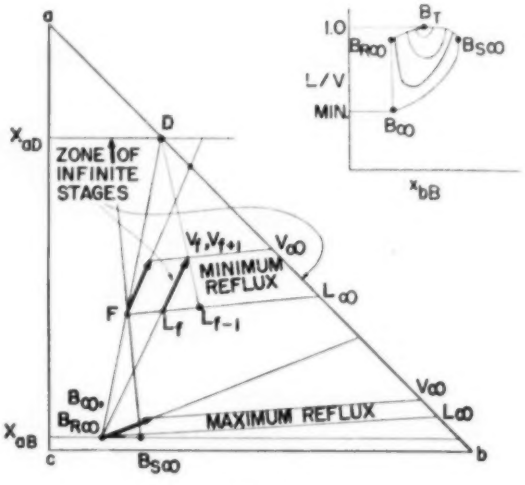


FIG. 8

intersection of the fractionation path up from the bottom product with the straight line path VV_∞ and LL_∞.

The minimum reflux ratio for the product B_R and D is limited by the development of a ternary zone of infinite stages in the rectifying section as shown in Fig. 5; to which the analysis of Fig. 4 applies with equal rigor; a finite number of stripping stages being required. This minimum value of L/V must be found by trial and error. At L/V values below the minimum value, the fractionation path up from the bottom will not intersect the straight parallel line path V_1V_∞ and L_1L_∞ at the tie line V_1L_1 which passes through the distillate point D.

The location of the products from the refluxed stripper with infinite stages, $B_{S\infty}$, and the products of the minimum reflux, B_∞, follow the methods previously described.

When the distillate specification, x_{aD}, increases to the point at which the tie line from the feed, F, intersects the binary base $a\,b$, the separation can be made with an infinite number of rectifying stages as shown in Fig. 6 or at the minimum reflux as shown in Fig. 7, or with an infinite number of stripping stages as indicated by $B_{S\infty}$ in Fig. 7 giving the fractionation envelope shown in the upper right corner of Fig. 7. It should be noted that the minimum reflux products coincide with those from an infinite rectifying column and that they can also be made at intermediate values of L/V similar to Fig. 4. At the minimum reflux the value of $L/V = DV_F/DF$ $\bar{L}/\bar{V} = BV_F/BF$, and the fractionation pro-

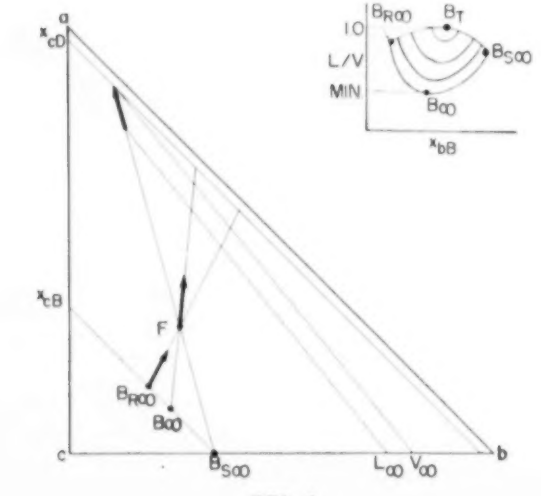


FIG. 9

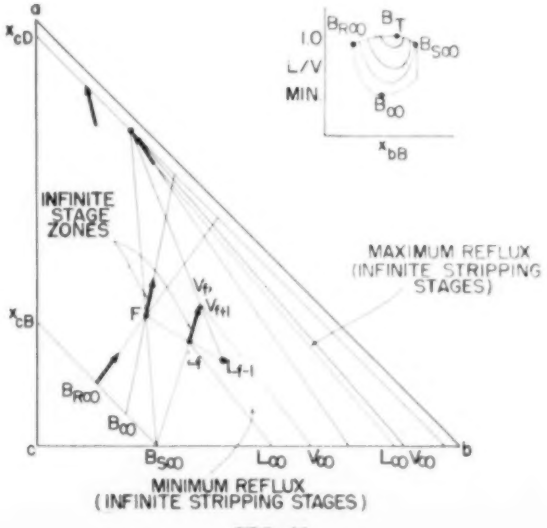


FIG. 10

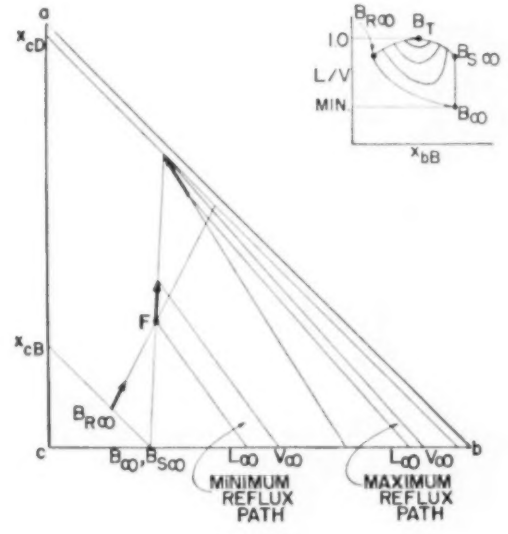


FIG. 11

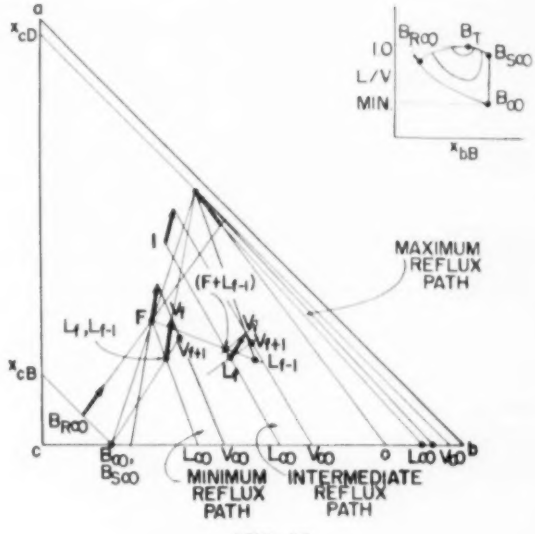


FIG. 12

gresses down from the distillate product through a binary zone of infinite stages to a ternary zone of infinite stages which includes the feed stage.

When the distillate specification, x_{aD} is increased above the value at which the tie line from the feed, F, intersects the binary base, $a\,b$, as shown in Fig. 8, the separation can be made with an infinite number of rectifying stages at a high reflux ratio (indicated by the path labelled maximum reflux in Fig. 8 and similar to Figs. 3 and 6) or at minimum reflux (indicated by the path labelled minimum reflux in Fig. 8) or with an infinite number of stripping stages similar to, $B_{S\infty}$, in Fig. 5 or at total reflux giving the fractionation envelope in the upper right corner of Fig. 8. The minimum reflux products coincide with those from an infinite rectifying column and can also be made at intermediate values of L/V similar to Fig. 4. At the minimum reflux, the ternary zone of infinite stages L_fV_f no longer includes the feed composition as in Fig. 7 but forms along the tie line of the straight parallel line path between the feed tie line and the binary infinite stage zone, which extrapolates through the bottom product. The minimum reflux value L/V equals DV_{x_i}/DL_{x_i}. It should be noted that the minimum reflux products can also be made at reflux ratios between the minimum and maximum values in a manner similar to Fig. 4.

Specification of x_{cD} and x_{cB}

The preceding discussion dealt with the specification of the most volatile component in both products. As

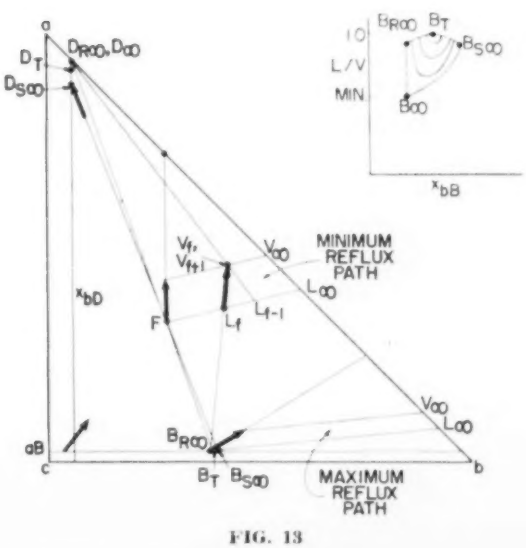


FIG. 13

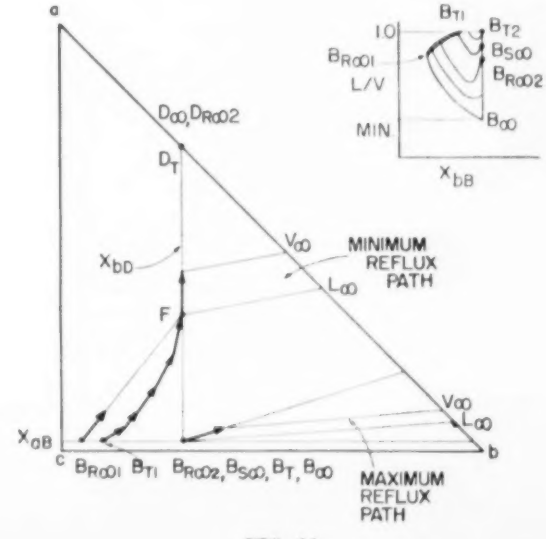


FIG. 14

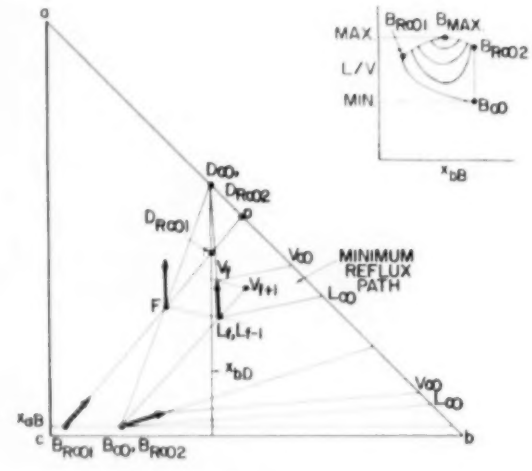


FIG. 15

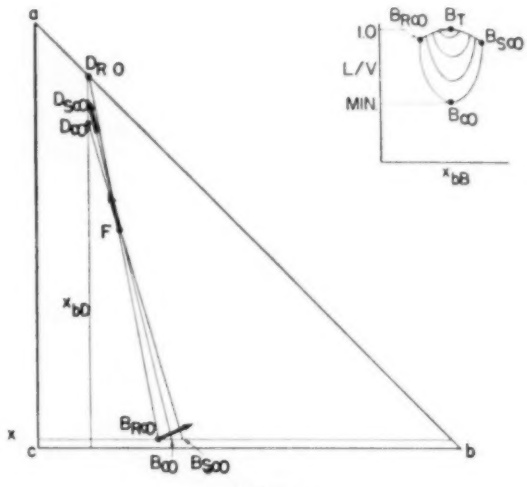


FIG. 16

might be expected the relationships for the specification of the least volatile component is similar in all respects as illustrated in Figs. 9-12. Fig. 9 is similar to Fig. 2. Fig. 10 incorporates the characteristics of Figs. 3, 4 and 5. Fig. 11 is similar to Figs. 6 and 7. Fig. 12 is similar to Figs. 7 and 8.

Specification of x_{aB} and x_{bD}

Where an intermediate component is specified in one of the products and an end component is specified as the other component, the fractionation relationships with infinite stages are slightly more complicated as was indicated by Fig. 5 of Article No. 2.[2] Such relationships are typified by fixing the concentration of the light component in the bottom product and of the intermediate component in the distillate as illustrated by Figs. 13-17. For simplicity, the case of a vertical tie line from the feed is discussed first (Figs. 13, 14 and 15).

In Fig. 13, the value of x_{bD} is low so that the relationships are the same as those of Fig. 8 previously discussed. In Fig. 14, x_{bD} has been made equal to x_{bF} so that the relationships in general are the same as those of Fig. 7. The distillate product corresponding to various finite stage columns lie between F and D and the fractionation envelope becomes a straight vertical line. In some respects, this is a degenerate case since if $x_{bF} = x_{bD}$ there is some question as to whether or not a *separation* has been specified for a complete column.

If one takes the point of view that a separation has been specified, then a set of dual solutions for a recti-

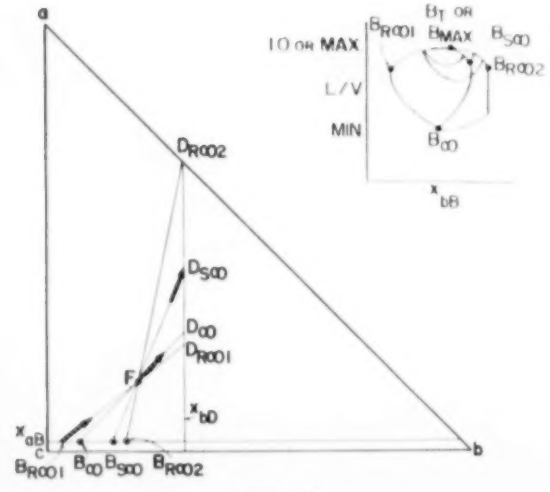


FIG. 17

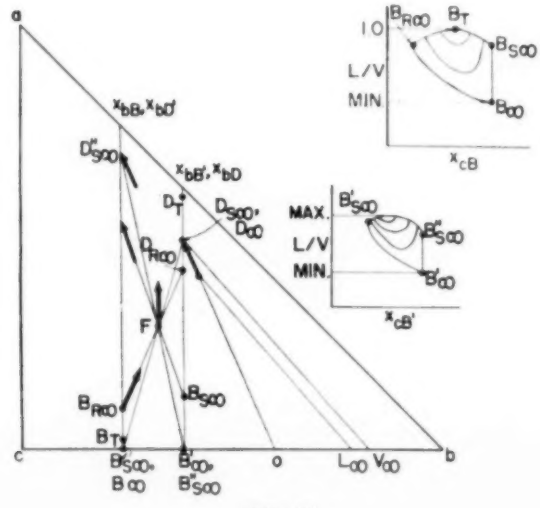


FIG. 18

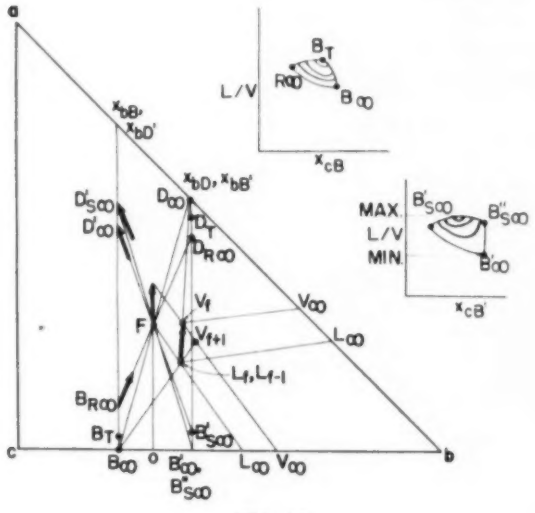


FIG. 19

fying column must be admitted ($B_{R\infty 1}$, B_{T1}) producing a zero quantity of bottom product.

When x_{bD} is greater than x_{bF} as shown in Fig. 15, two bottom products corresponding to rectifying columns containing infinite stages become available indicated by $B_{R\infty 1}$ (similar to B_R of Fig. 1) and $B_{R\infty 2}$ (similar to Fig. 5). When x_{bD} is only slightly greater than x_{bF} it may be possible to make the separation at total reflux but usually will not be possible. It is impossible to make the separation in a refluxed stripping column and the minimum reflux relationship is similar to that of Fig. 5; indicated by the lines labelled "minimum reflux path." This leads to a fractionation envelope such as is shown in the upper right corner of Fig. 15 which is bounded at the top by a curve between $B_{R\infty 1}$ and $B_{R\infty 2}$ representing the products from rectifying columns at various values of L/V probably passing through a maximum value (although not necessarily), the number of stages passing through a minimum value along the curve $B_{R\infty 1}$ $B_{R\infty 2}$, similar to the locus of minimum stages of Fig. 5 of Article No. 2.[2]

As the value of x_{bD} is increased until it approaches point 0 of Fig. 15, the intersection of the tie line from x_{aB} through the F, the fractionation envelope shrinks to a straight vertical line as in Fig. 14. Separations to values of x_{bD} above this value are impossible.

Where the tie line from the feed point inclines upwards to the left as in Fig. 16, at values of $x_{bD} < x_{bF}$, conventional fractionation envelopes may exist as shown. At values of $x_{bD} > x_{bF}$, fractionation envelopes of the same type as in Figs. 13-15 result.

Where the tie line from the feed point incline upward to the right as in Fig. 17, it may be possible to effect the separation in a refluxed stripping column as indicated by the points B_{Sx} and D_{Sx}. This gives rise to a branched fractionation envelope as shown in the upper right corner of Fig. 17. As the value of x_{bD} is increased this branch rapidly disappears.

Specification of x_{bD} and x_{bB}

The specification of the intermediate component in both the distillate and bottom products is illustrated in Figs. 18-20. When the specification loci are close to the feed as in Fig. 18 it is possible to meet a given specification of x_b either as a distillate or as a bottom product. If the lesser value of x_b is taken for the bottom product, the point not labelled with primes results and the upper fractionation envelope is developed. This part of the diagram is similar in all respects to Fig. 12. On the other hand if the lesser value of x_b is taken for the distillate product then the primed points result and the lower fractionation envelope is developed. Here it may or may not be possible to make the separation at total reflux and the separation may be made in two ways with a refluxed stripping column containing infinite stages similar to Fig. 15 and represented by the point B'_{Sx} and B''_{Sx}. The minimum reflux calculation follows a path similar to that labelled "minimum reflux (infinite stripping stages)" of Fig. 10.

When the higher value of x_b taken as a distillate product is increased as shown in Fig. 19, at minimum reflux both the distillate and bottom products may be binary mixtures, a fortuitous and unique case, as indicated by the points B_x and D_x. Here, the fractionation down the column proceeds through a binary rectifying zone of infinite stages, then through the ternary zone of infinite stages just above the feed stage and controlled by the tie line through the distillate product and finally through a binary stripping zone of infinite stages before passing to the bottom product. The solution for the refluxed stripping column of infinite stages merges with the minimum reflux calculation producing the upper fractionation envelope.

On the other hand the lower fratcionation envelope decreases sharply in size as the value of x_b taken as a bottom product increases although its form remains unchanged. When the greater value of x_b is increased to the point shown in Fig. 20, the lower fratcionation envelope has shrunk to a single point and the upper fractionation envelope transforms to one of the type of Fig. 15. As the higher value of x_b is increased to the point 0 in Fig. 20, then the upper fractionation envelope disappears.

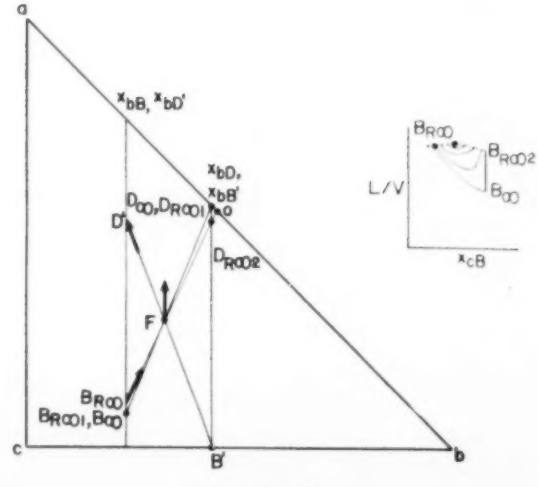


FIG. 20

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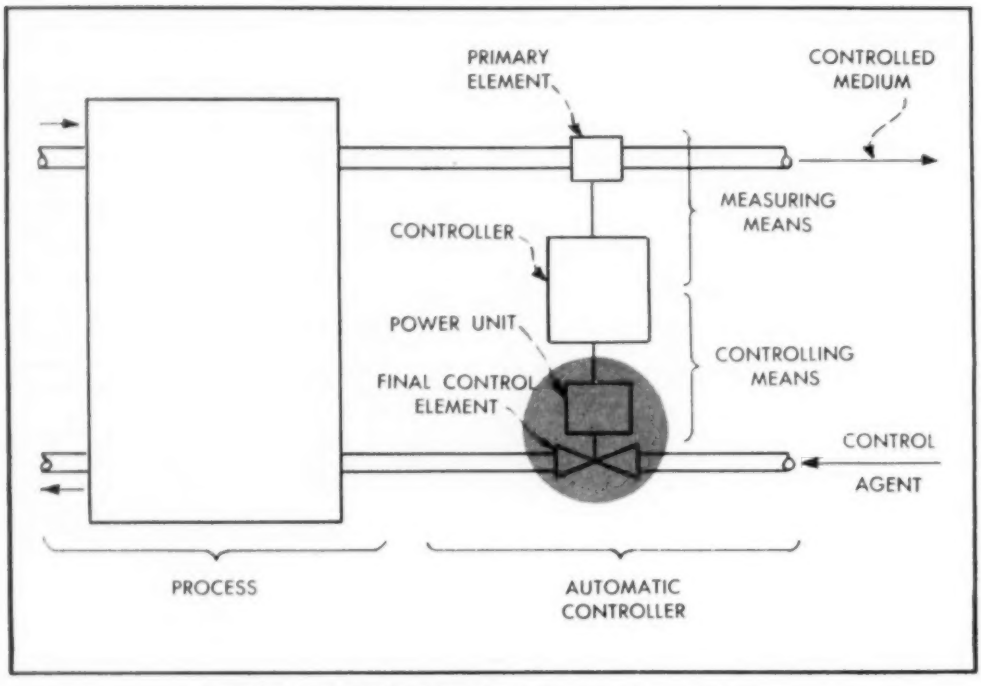
(1) White, R. R., PETROLEUM PROCESSING, 8, 1026, (1953).
(2) White, R. R., *ibid.*, 8, 539, (1953).



TYPICAL PROCESS CONTROL diagram shows that . . .

Valves Are in the Control Loop

In an automatic process, they rate attention equal to that given all parts of the system

By E. WOLFF, Chief Engineer, Valve Division, Minneapolis-Honeywell Regulator Co.

THE growing dependency of industry upon automatic process control has created a need for a better understanding of the functions of diaphragm motor control valves. The valve is no longer merely a mechanical gadget stuck at random in a length of pipe. Rather it's an element among other elements—all of equal standing—in a complete system (see drawing above) which is recognized as the control loop.

Today, the design, specification, installation, or maintenance of automatic control valves is in the field of control loop engineering. It is apparent that what we do with one element (e.g. the valve) affects the other element (e.g. the instrument or process) and vice versa. This principle is widely recognized and concentrated efforts are being made to develop a practical working knowledge of these interacting forces. However, since daily problems call for immediate solutions, it is desirable to emphasize again the essential functions in a diaphragm motor control valve and, at the same time, to highlight some practical considerations as expressed in the specifications associated with these basic functions.

The conventional diaphragm motor control valve can be broken down into two functionally separate units: first, the diaphragm motor which converts a pressure into a stroke, and, second, the valve proper which changes the flow as a function of stroke.

The diaphragm motor operator, in order to fulfill its essential function, namely converting pressure into stroke, needs two essential components: (1) a diaphragm to furnish an area, and (2) a spring to supply a variable counterforce.

Considering the control loop, must this conversion into stroke be accomplished with any particular characteristic? If so, what are these characteristics? It is generally agreed that the pressure-stroke characteristic should be a straight line. The reason is not difficult to understand. The pressure-stroke conversion is only a tool helping to convert instrument air pressure into varying flow in accordance with a definite pattern governed by the process to be controlled. Therefore, any but the simplest characteristics in the diaphragm operator would only complicate matters.

On the surface, it seems quite simple to obtain such a straight line characteristic if we remember that a spring has theoretically a linear force-deflection curve, and a diaphragm has an area which is considered constant. However, it is not quite as easy as that, because the area of the diaphragm (Fig. 1) changes substantially in the course of displacing itself, and the spring characteristic (Fig. 2) also deviates from the theoretical straight line.

To obtain the desired straight line characteristics within certain specified limits, proper design of the components, such as the shape of the diaphragm and the type and number of coils of the spring, is required. Actual test results (Fig. 3) of a valve with 3-in. travel show how the straight line characteristic has, for all practical purposes, been obtained.

The supporting structure for the diaphragm motor, commonly called the yoke, can be either the open or enclosed type (Fig. 4). An enclosed spring as a protective measure and an open yoke to allow ease of adjustment and maintenance form the most desirable combination. The tubular yoke is obviously more difficult from a maintenance viewpoint, while the all-open construction encourages the collection of foreign matter around the spring.

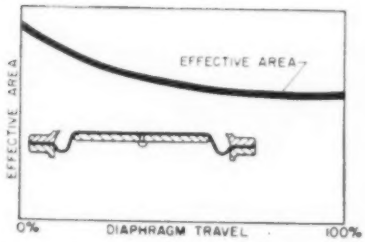


FIG. 1—Variation of effective area with diaphragm travel

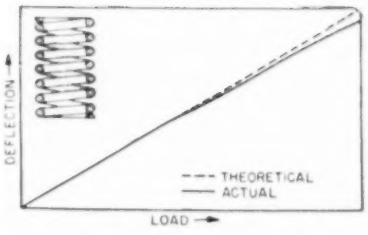


FIG. 2—Variation of spring characteristic from theoretical linearity

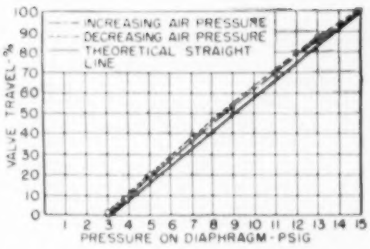


FIG. 3—Results of hysteresis test on six-inch valve

Another important detail of the yoke is the method employed to connect it to the valve proper. This can be accomplished in a number of different ways with the criterion being proper alignment of the two moving members, namely the operator and the valve stem. Illustrated in Fig. 5 are three representative solutions.

The first (A) provides for a slip fit and positive locking. The second (B) uses a groove and set screws. The third (C) provides for bolting to the valve bonnet flange. The latter method permits removal of the yoke without disturbing the stuffing box, thus permitting the substitution of a larger actuator in order to overcome unexpected unbalances within the valve without removing the valve from the line.

Rough treatment is a possibility with control valves. The subject of good alignment again enters the picture in connection with yoke material and construction. In this case, it is not what happens after the valve is installed but what has happened to the valve during shipment and installation. It may go through some rough handling. Therefore, a number of users frown upon the tubular steel construction which, although stronger and not likely to break, can become slightly deformed if subjected to rough treatment. More than likely, the deformation will go unnoticed until the valve is in the line and becomes inoperative due to poor alignment of parts. A good clean break and replacement before installation is certainly preferable.

Practical considerations: As pointed out earlier, the essential function of the diaphragm motor is to convert pressure into stroke and the characteristic of this conversion should be linear. Other considerations are concerned with the pressure range producing full valve stroke and with the amount of permissible hysteresis.

An air pressure range of 3-15 psi has been established as an industry standard for the instrument signal range which corresponds to the full travel of the valve. Like any other engineering dimensions, tolerances must be given for this range and they should be uniform and consistent with actual installation requirements. Such tolerances are given within ±2% of the pressure range (2¾ to 15¼ psi), ±5% (2.5 to 15.5 psi), or ±1 psi (2 to 16 psi). All these specifications can be met, but naturally one adds to the cost of the valve more than the other, considering particularly that commercial spring tolerances are at least ±5%.

The tolerances for linearity and the amount of permissible hysteresis are of the same magnitude, range from 1 to 5%.

Auxiliary devices: With the present-day advance in control instrument performance, the volume of the diaphragm chamber becomes significant. This volume should be kept to a minimum consistent with the diameter of the diaphragm required to produce a given valve travel, and with the area of the diaphragm required to produce sufficient force to overcome unbalances within the valve. If the speed of response requirement on an application is faster than the instrument pilot by itself can provide and the given volume of the diaphragm chamber permits, these auxiliary devices such as positioners, volume boosters, etc., are used to get faster valve action.

Positioners: One of the reasons for the use of a valve positioner, of course, is to position the diaphragm motor stem to a more accurate degree than is possible with an instrument alone. Another reason is to obtain additional power and to be able to do work at the end of the valve stem. Normally, the force exerted by the diaphragm is fully absorbed by the spring—thus no external work can be accomplished by the stem. Work can be done if the spring air range, 15 psi for instance, is exceeded by additional air pressure applied to the diaphragm 18-20 psi, for example.

However, this small surplus pressure of 2-5 psi—the maximum generally available from the instrument pilot—is not sufficient in all cases to overcome the unbalances such as may be encountered in single-seated valves. In such cases, a positioner can be used as a source of power even if its positioning qualities are not particularly required. The independent air supply to the positioner can be stepped up to 50 psi, adding much more power to the diaphragm motor stem.

It should be noted, however, that this power obtained through higher air pressure is available only in one direction. The return stroke must be powered by the energy stored in the spring. Selection of the spring, therefore, must be governed by the unbalances within the valve.

Irrespective of the spring selected, the positioner adjustment automatically takes care of the 3-15 psi signal air range of the instrument. By the same token, split range spring action (3-9, 9-15 psi) for sequencing control can be obtained through positioner adjustment on a diaphragm motor equipped with a standard 3-15 psi spring.

Positioners also have an effect on valve travel time because their pilots can be supplied with larger air capacities than standard instruments

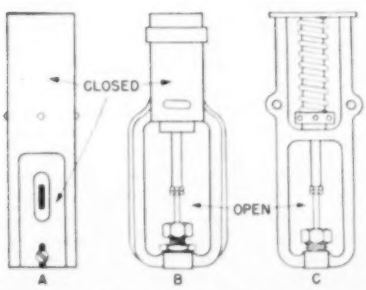


FIG. 4—Yoke and spring barrel constructions

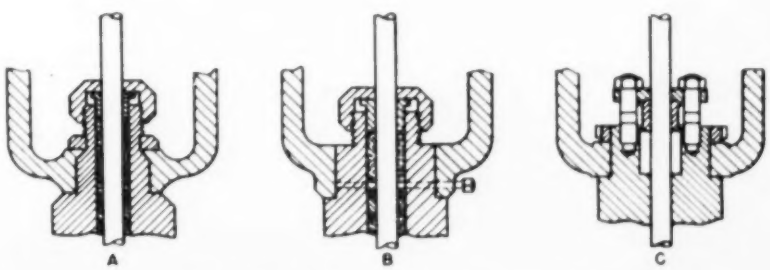


FIG. 5—Various yoke-to-bonnet connections

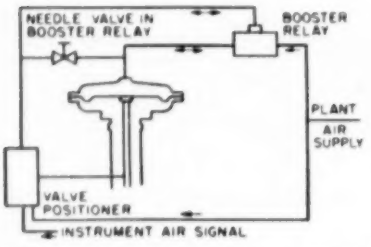


FIG. 6—Volume booster in typical control system

can provide. However, even with the largest capacity positioners, large sized valves for some applications need speed of response beyond that which a positioner can furnish. In such cases, volume boosters are most frequently used.

Volume boosters: Here again in principle, a relay of large capacity with an independent air supply responds to a controlled air signal, either from a positioner or directly from the instrument. The effectiveness of such boosters can best be illustrated by an example. A 14-in. valve of double-seated design with spring-type diaphragm motor and equipped with a standard capacity positioner has a travel time of approximately 40 sec. (air pressure changed suddenly from its maximum 15 to the minimum 3 and vice versa). By adding a volume booster, travel time is reduced to 10 sec. Caution is necessary in applications of this type in tuning the valve speed to the over-all system response so that hunting or cycling is avoided. (see Fig. 6)

Air lock: A spring-type diaphragm motor by definition must have a predetermined position with 0 psi air pressure. Most control applications can be handled satisfactorily by the valve either assuming a fully-opened or fully-closed position upon failure of the air supply to the diaphragm. However, in many applications, more efficient over-all process control would be realized if the valve would stay in the prevailing position at the time of air failure.

Use of an air lock (Fig. 7) which, as the name implies, locks the air in the diaphragm chamber is one method of holding the valve at the prevailing position. While this arrangement will leak a fraction of a pound in the course of a few hours time, restoration of the normal air supply can usually be accomplished before any major change in plug position occurs.

Handwheel operators are another device which concerns the actuator and which are becoming more and more popular. Essentially there are two types: one for top of diaphragm mounting and the other for side mounting. Regardless of type, this device permits manual control in case of air or diaphragm failure. It also provides a means of limiting the valve travel during automatic operation.

If headroom is no problem, interruption of valve operation is permissible while replacing the diaphragm, and the limitation of travel in one direction only is allowable, then the top-mounted handwheel is the most economical selection.

On the other hand, the current trend toward eliminating by-passes and block-out valves for control valves over two inches makes the side-mounted type mandatory. As shown in Fig. 8, two types of side-mounted operators are available, namely: Type I which employs a fork that must be manually slipped into a grooved ring on the stem, and Type II which is continuously connected utilizing a bellcrank and a screw.

The advantage of Type I is that the valve can be operated positively in both directions; the disadvantage is that the operator must line up the fork with the grooved ring which may prove too time-consuming in cases of emergency. The Type II operator on the other hand eliminates the necessity for manual engagement, but it depends upon the actuator spring and plug unbalances for positive positioning.

This article deals mostly with spring-type diaphragm motor operators. The springless diaphragm motor—a subject in itself—has not been generally accepted as a stroke-producing unit for control valves. The main reason, no doubt, is its inherent inability to take a definite position in case of air failure. Actually, this can be accomplished but it adds to the complexity of the unit and to the maintenance cost.

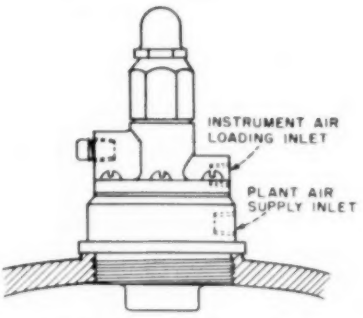


FIG. 7—Air lock assembly

The valve body's function is to vary the flow (variable orifice) in accordance with the dictates from the actuator. There are innumerable types of valves, such as double-seated, single-seated, Venturi, butterfly, internal pilot, Saunders and others, which diaphragm operators can operate. Each of these has been designed to meet definite application conditions. All of them, however, can be stripped down to some common essential components.

The most essential part in any valve is the disc or plug which is moved in some fashion by the actuator to vary an orifice area and thus vary the quantity of the controlled medium. It is expected that this change of flow is accomplished in accordance with a definite pattern or characteristic which matches the requirements of the control loop. It is further expected that the characteristic is effective over a specified range of conditions or, in other words, that the plug has a certain amount of rangeability.

Because both terms, namely characteristic and rangeability will be used, it is important to define each accurately. Equal percentage and linear characteristics refer to a theoretical graph which depicts how the flow across a variable orifice changes with travel (of actuator) while the differential pressure across it remains at an undefined constant value.

Rangeability is usually defined as the ratio of maximum to minimum controllable flow or as the ratio of maximum to minimum C_v. However, once the valve is installed and subject to all the influences of the piping system, the actual characteristic deviates in varying degrees from the beautiful curves illustrated. The same applies to the calculated and published rangeability figures.

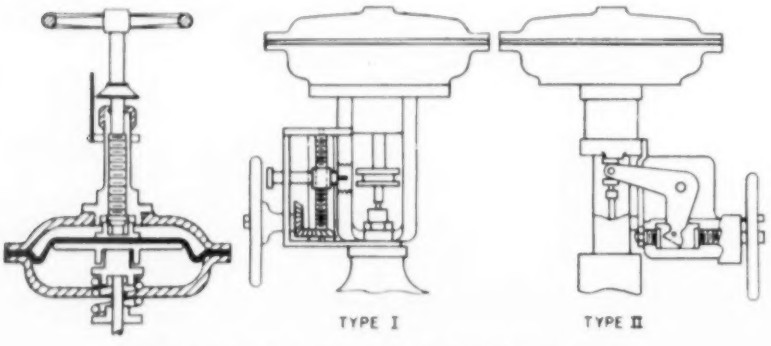


FIG. 8—Top and side-mounted handwheel operators

Some of the factors which are responsible for these deviations are: the change of pressure drop across the valve as loads vary; valve body contours; the ratio of valve port area to adjacent pipe area; and the losses through piping and equipment in relation to losses within the valve.

While it is generally agreed that these factors affect the characteristic and rangeability of control valves, it is not common practice as yet to apply them in the design or selection of valves for a given process condition. However, being aware of these facts brings the term of characteristic and the figures of rangeability as commonly used into the right perspective.

Application influences plug selection: From a construction viewpoint, the simplest plug is the single or double-seated poppet or bevelled type. It is used mostly for on-off service or where a linear characteristic with limited rangeability is acceptable. Applications permitting narrow proportional band setting (10%) use plugs of this type quite successfully.

However, for processes requiring wide proportional band setting, the V-ported or contoured plugs with either linear or equal-percentage characteristic are used. The equal-percentage type is used in considerably larger quantities than the linear type. Undoubtedly, there is good reason for such a preference, as in terms of control loop engineering, the plug characteristic should be tuned to the process characteristic with the goal of obtaining equal stability at all loads. However, the equal-percentage plug should not be considered a "cure-all."

As previously mentioned, the influence of the adjacent piping and process equipment upon the flow-lift characteristic further favors the selection of the equal-percentage plug. This influence tends to change the equal-percentage characteristic in the direction of the linear one. With the use of a linear plug under the same conditions, the characteristics of an on-off plug would be approached which might result in undesirable stability conditions.

Equal-percentage vs. linear plugs: Both equal-percentage and linear characteristics can be obtained with V-ported or contoured type plugs in either single or double-seated design. Double-seated plugs (Fig. 9) are the predominant choice at present due to the theoretical semi-balance they offer, permitting the use of the simplest type of actuator, namely the spring-opposed diaphragm motor—an important consideration where maintenance costs must be kept to a minimum.

This static unbalance is due only to the difference in seat ring area required for assembly. However, even this can be avoided, again theoretically, with the use of piston-type plugs which do not require seating surfaces. Dynamic unbalances, however, are always present in any type of double-seated plugs and recent investigations have thrown some valuable light on this phase of valve operation.

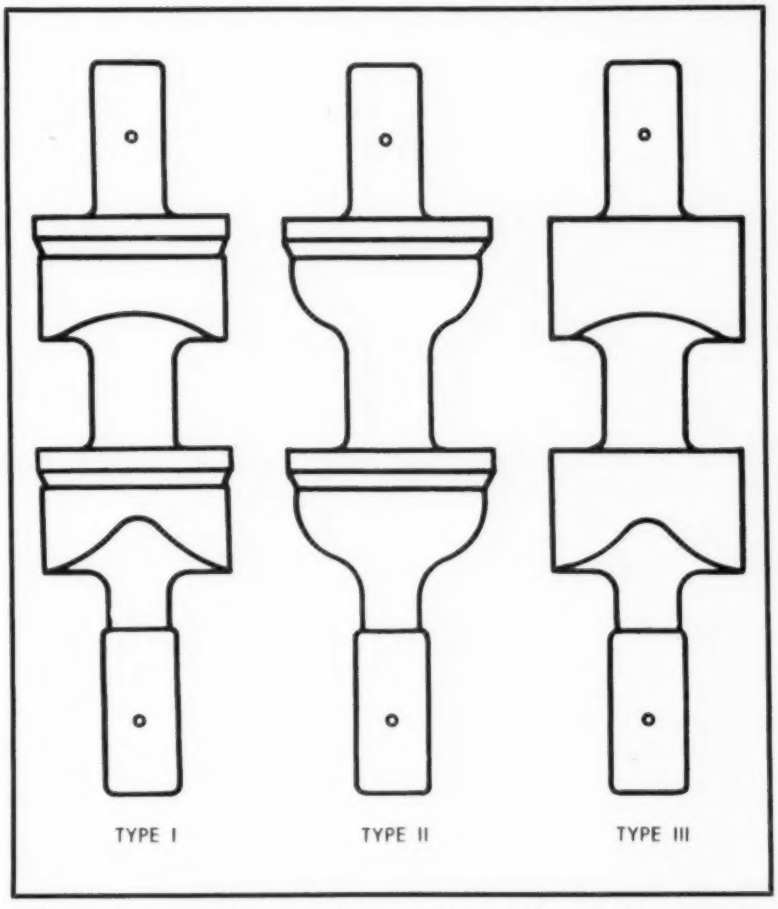


FIG. 9—Types of double-seated plugs: I and II, semi-balanced; III, balanced; I and III, V-ported; II, contoured

Disregarding the piston-type, there are four types of plugs to choose from, namely: the skirted (V-ported) and contoured designs with either linear or equal-percentage characteristics.

Which One to Use? The majority of valve users appear to favor the top and bottom guided plugs with equal-percentage characteristics as a standard, unless individual specifications dictate otherwise. There is an outspoken preference for the V-ported type. The reason is sound. The very close clearance when a contoured plug nears the seat ring can be dangerous unless the fluid is clean.

As one user specification puts it: "Equal-percentage contoured plug permitted providing satisfactory characteristic and sufficient clearance are available to avoid rubbing under anticipated temperature and pressure conditions."

There are others, however, who feel differently about it. A chemical company specifies equal-percentage, contoured types up to and including 4-inch size; V-ported plugs for sizes 6 in. and larger. Still other users have standardized on the linear type.

There are no hard and fast rules governing plug selection. The wide preference for V-ported, equal-percentage plugs can only serve as a guide. The actual conditions of each application should be carefully analyzed and the type of plug selected which will best meet the requirements. Since this is not always the V-ported plug, valve manufacturers make all plug types available. Their rangeability varies from 30:1 to 50:1 depending upon the characteristic and upon the type of plug.

Stainless steel is preferred for valve plugs, usually 18-8. In some applications, where the flowing medium is highly abrasive or where the danger of corrosion exists, particularly under high pressure drops, the seating surfaces of both plug and seat ring should be stellited or other hard-facing material should be used. Practice finds bronze trim

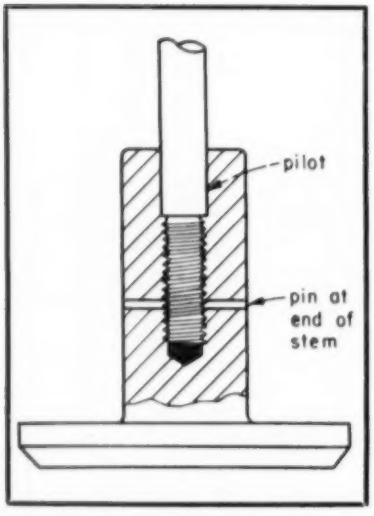


FIG. 10—Plug-stem connection

used up to 150 psi drop; stainless steel up to 300 psi; 440 hardened stainless steel up to 450 psi; and stelliting above the latter figure.

As mentioned before, preference is strong for top and bottom guiding of valve plugs. The primary function of these bushings is to segregate the necessary guiding function from the control function of the plug, thus avoiding wear at the plug skirt, and at the same time to provide the necessary alignment. Guide bushings are, of course, imperative for contoured-type plugs. The bushings should be considerably harder than the plug post, a minimum of 100 Brinell hardness. The preference of users is evenly divided between the pressed-in and screwed-in types. For both, advantages and disadvantages could be listed. The essential points are that perfect alignment is achieved, the bushings stay put in service, and they can be easily removed for maintenance.

The connection between plug and stem is another important detail because it has to be strong enough to withstand both longitudinal and torsional forces without play. In addition, the connection should permit easy reversibility in the field. These qualifications are met by screwing the stem into the plug post and pinning it near the end of the stem (Fig. 10). This seems to be general practice and if carefully applied represents a simple solution.

The bonnet and stuffing box: While definite standards exist for joints between body and pipe, there are none for bonnet and blind flanges even though they are part of the pressure vessel.

Basically, the bonnet can be either screwed or bolted to the body proper. Most specifications call for bolted construction starting with one-inch nominal valve size.

If bolted, a leak-tight joint can be obtained by either a gasket or by metal-to-metal contact (ground joint). The latter has a definite disadvantage in that regrinding is necessary if the flange is inadvertently nicked. Therefore, most valves of the bolted type use gaskets of either the flat or enclosed type. It is often desirable that the bonnet and blind flanges be piloted in the body for alignment. The maximum clearance for such piloting is specified in some cases as not to exceed .005 in.

The stuffing box, usually an integral part of the bonnet, is one of the critical components of the valve. Good design is predicated on a minimum of leakage and friction, and great advances have been made recently in this direction with the advent of Teflon (tetra Fluoroethylene) as a valve packing material.

This du Pont development has found wide use as a valve packing material because of its moldability, low friction qualities and chemical inertness. The use of Teflon precludes the need for lubrication and permits a reduction in the depth of the stuffing box.

What is valve trim? Years ago, only the plug and seat ring of a valve fell into the category of trim. Today, trim is generally accepted as including all parts which come into direct contact with the flowing medium (excluding, of course, the body itself). This would include disc, seats, guide bushings, packing retaining ring, packing gland and grease cage.

The body proper, and more specifically its shape, is perhaps influenced more than any other part by application requirements — which point more and more in the direction of higher pressure drops and, therefore, higher velocities. Basically, the body is a pressure vessel which, like the adjacent pipe, has to meet code requirements based on a certain pressure-temperature material pattern. The body is also subject to turbulence and pressure losses like any other fitting or piece of pipe run.

We worry a great deal about valve characteristics, but we often fail to put sufficient emphasis on sound body design and its influence on these characteristics. Plug characteristic curves are certainly influenced in actual application by adjacent piping, and valve body contours have a like effect upon these characteristics.

What are some body considerations? We know that changing the direction of a moving part involves work which can be expressed in dollars. It makes no difference whether such a moving part is solid or liquid. If we force a fluid through the tortuous convolutions and passages of a conventional double-seated body, changing the direction of flow every fraction of an inch, then work is being done. Instead of the valve providing reasonable channels which the fluid can follow under prevailing velocities, the fluid itself must set up these channels by filling out the sharp corners and crevices with cushions—usually called eddy currents and turbulence. We pay for this work done by the fluid in terms of pressure losses.

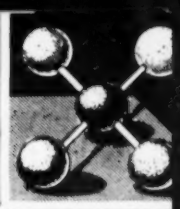
Improper valve body design affects not only control valve characteristics but also capacities, especially at higher differential pressures. There must be a pressure differential across a control valve in order to make the valve function properly as part of the loop. However, this pressure drop should be concentrated across the variable orifice as represented by the seat ring and plug at all conditions, and the loss in the body passages should only be a small fraction of such drop. This can be done by selecting the proper ratio between inner valve port area and body passage area or by providing streamlined body designs to minimize possible losses in passages due to eddy currents. If this is done, expected characteristics can be more nearly obtained.

However, it might be necessary to sacrifice capacity, because, in order to obtain the above mentioned proper ratio of areas, the inner port must be of reduced size. This is necessary because the inlet and outlet area of any valve can not be greater than those of the adjacent pipe. Good flow characteristics over a wide range of differential pressures cannot be obtained with inner port area equal to valve inlet and exit area. A control valve is not bought or sold on capacity alone.

Meet the Author

E. Wolff has for the past eight years been chief engineer of the valve division, Minneapolis-Honeywell Regulator Co., Philadelphia. Born in Berlin, Germany, he received an M. E. in 1930 from the university at Darmstadt, Germany. Later he obtained a doctorate in engineering through work performed at the Aerodynamic Experimental station in Gottingen.

Following this, Dr. Wolff worked for many years in the aircraft industry in Europe and in the United States. He has been associated with the instrument control industry for the last 15 years, and is a member of the American Society of Mechanical Engineers and the Instrument Society of America.



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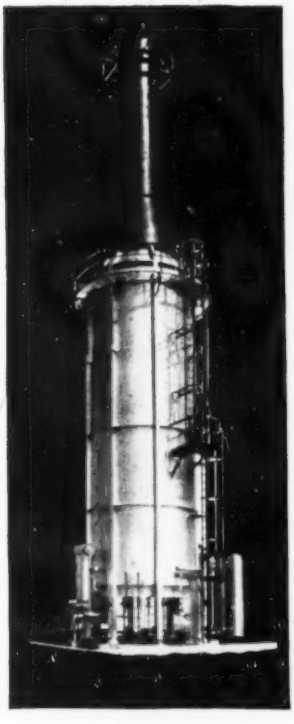

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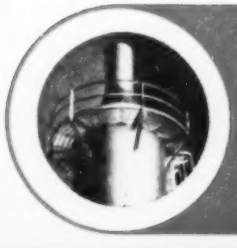

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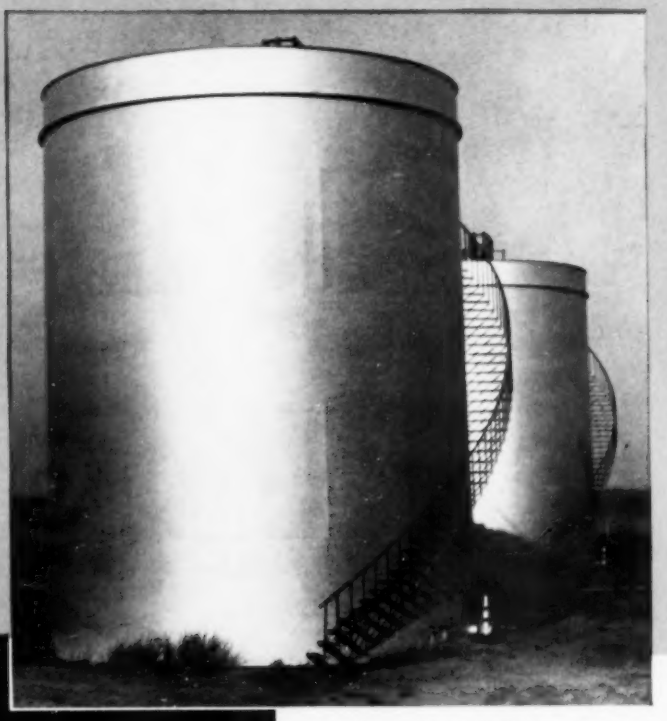
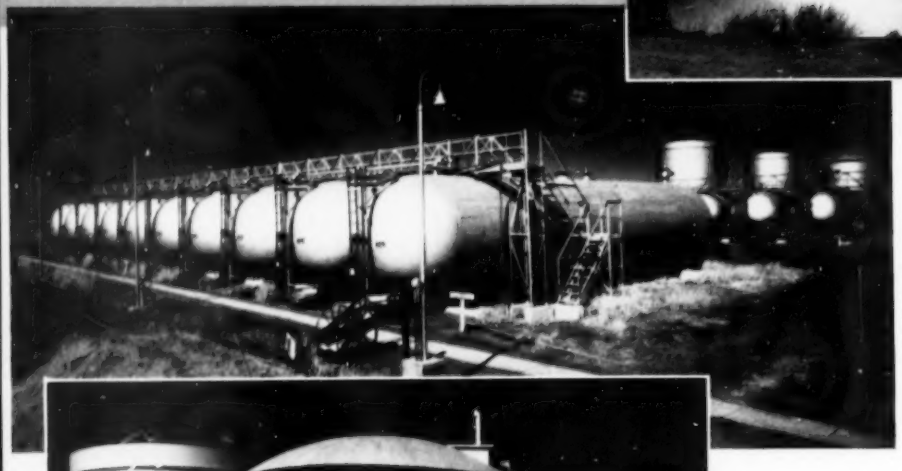
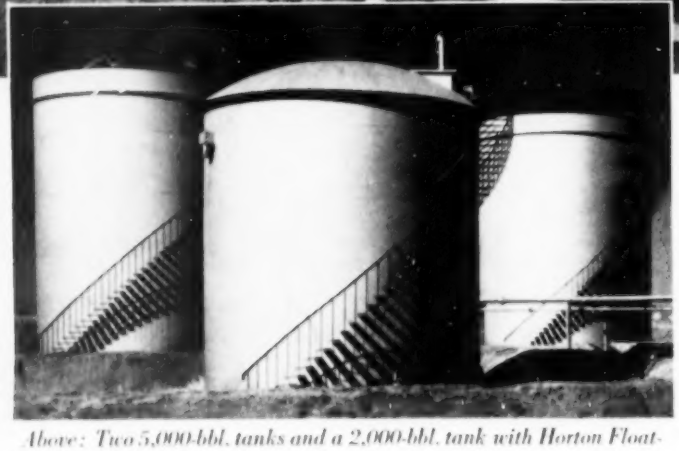




Above: Two 5,000-bbl. tanks with Horton Floating Roofs used to store acetone and other petro-chemicals at Celanese Corporation of America's Bishop, Texas plant.

Left: Ten cylindrical tanks with hemispherical ends for the storage of butane at the Bishop, Texas petro-chemical plant.



Above: Two 5,000-bbl. tanks and a 2,000-bbl. tank with Horton Floating Roofs. The 2,000-bbl. tank has an umbrella "weather" roof and the Horton Floating Roof inside. All are used to store petro-chemicals.

in Bishop, Texas

Chicago Bridge & Iron Company supplied the tanks shown here for the Celanese Corporation of America's $30,000,000 petro-chemical plant in Bishop, Texas. This plant — using convenient, abundant supplies of natural gas for raw material and fuel — produces the basic chemicals used in making Celanese yarns and plastics, plus many other important chemicals.

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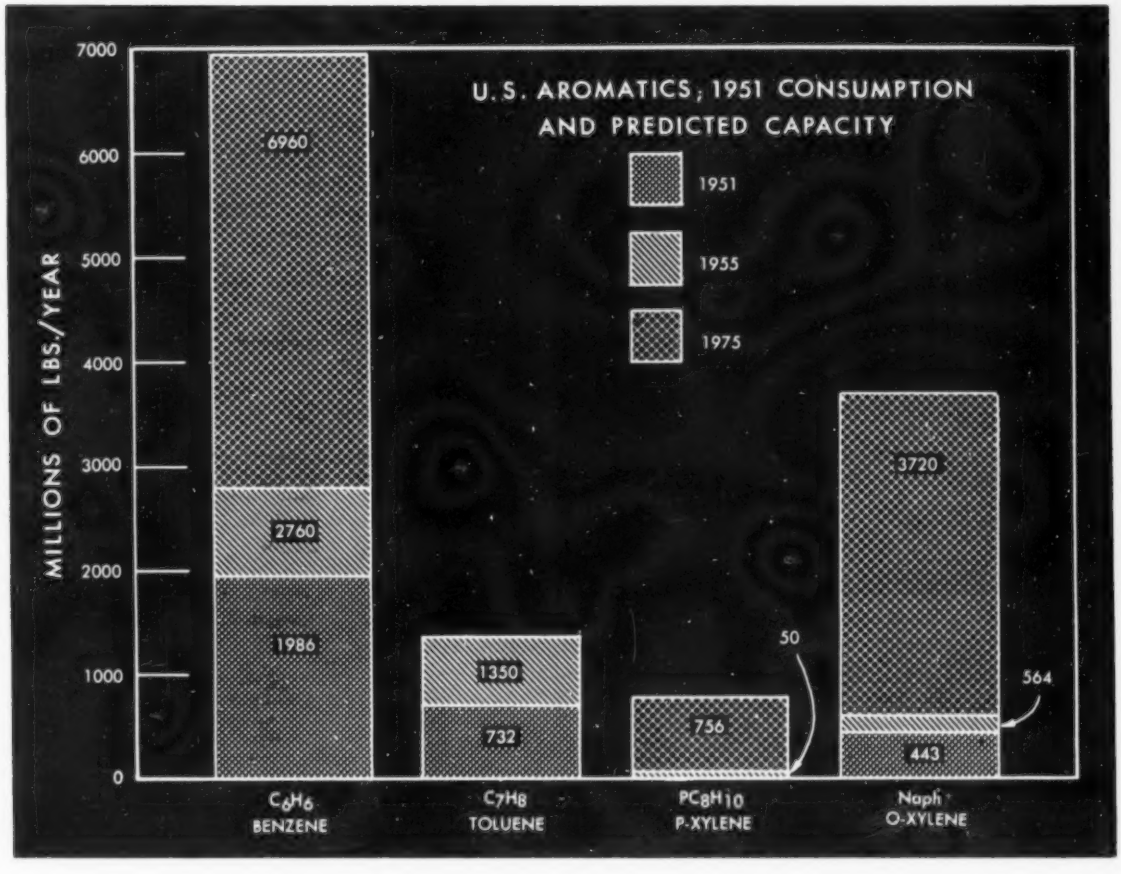


Aromatics from Petroleum

Oil industry offers many synthesis and recovery processes useful for supplying pure products

By D. S. MAISEL
Standard Oil Development Co.

LARGE-SCALE production of pure aromatic hydrocarbons from petroleum is one of the most rapidly expanding petrochemical outlets today. Chemical demand for these compounds has increased tremendously within the last ten years until it has exceeded the quantities which can be recovered from traditional coking sources.

Faced with this situation, the petroleum industry has been a logical place to look for quantities to satisfy current demands. Current consumption and estimated future capacity for the more important aromatics are shown in the chart above. The 1950 rates were obtained from U.S. Tariff Commission Reports; 1955 predictions were based on Defense Production Administration goals and the 1975 estimates were taken from the President's Material Policy Commission Report "Resources for Freedom."

It is clear that the most important chemical aromatic, volume-wise, is benzene and that, furthermore, consumption in the U. S. may undergo a 350% increase over the next 20-25 years. The 1955 figure, for example, is equivalent to about 24,000 b/d. It may give some perspective to note that benzene is the chief raw material for the manufacture of such important products as styrene, nylon, phenol and aniline.

Toluene is, at present, largely used as a solvent or in aviation gasoline. Its chief chemical outlet for TNT is, of course, a function of international relations. Recently, in face of an acute benzene shortage, efforts have been made to develop toluene as a benzene substitute. The production of methyl styrene is an example.

Xylenes have also been used as solvents. The development of fibers such as terylene and Dac-

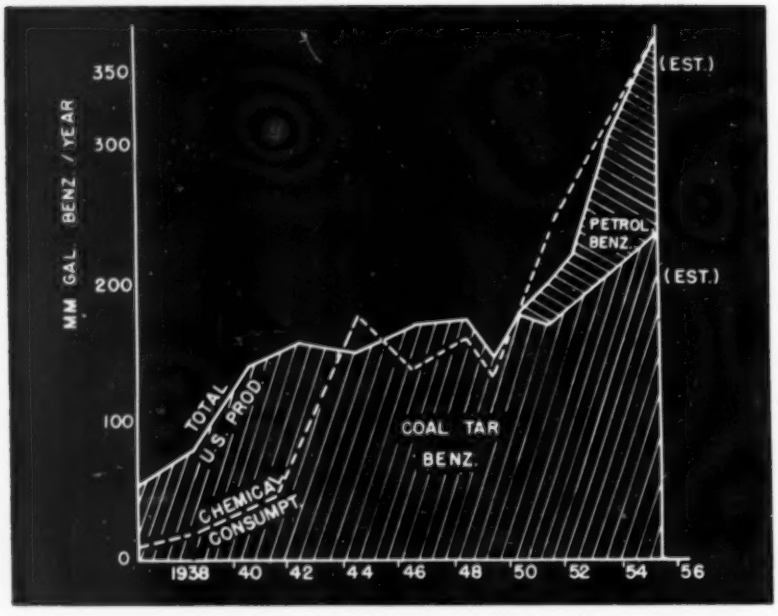


FIG. 1—Benzene production and consumption

ron provides a market for paraxylene of about a projected 50,000,000 lbs. in 1955 to grow perhaps to 756,000,000 lbs. by 1975.

The last column in the chart indicates that naphthalene, which finds a chief outlet in the manufacture of phthalic anhydride, or its possible substitute ortho-xylene, will probably undergo a large expansion in the future.

Fortunately, the development of the modern internal combustion engine has led to intensive work by the oil industry to improve gasoline quality. It has also been fortunate that aromatic hydrocarbons are premium ingredients in these gasoline blends, and have highly desirable octane ratings. Thus, there have been developed in the quest for better fuels, techniques which have also shown how to produce and recover aromatics from crude oil. When the need for pure aromatics exceeded that available from coal coking, the know-how and experience were available in the petroleum industry to provide immense additional amounts.

The story of benzene production, for example, is intriguing. Fig. 1 shows how chemical demand has exceeded supply. As recently as 1938, the total amount of benzene consumed in chemical outlets was only about 30,000,000 gals./yr. compared to about 85,000,000 gals. available from coal tar.

When World War II started, benzene consumption rose rapidly until, in 1943, it exceeded U.S. production by 30,000,000 gallons. The deficiency was supplied largely by imports from Europe. After the war, supply and demand were in a very tight balance until start of the Korean conflict when demand again exceeded U. S. production.

A permanent supply increment was obviously needed and petroleum has filled the gap. Starting in 1951 with little or no petroleum benzene, about 130,000,000 gals./yr. will be produced by 1955. This represents a remarkable achievement in that it was possible, over a period of four years, to design and contruct units to produce about 50% as much benzene as is obtained from the coking of more than 100 million tons of coal per year.

Synthesis Processes

Obviously, the background for this achievement was developed over a considerable interval of time. One of the earliest attempts to recover aromatics from petroleum was that of the Nobel Brothers in England in 1885, who set up and ran a small unit for making benzene by thermal cracking of crude oil fractions.

The stirrings of such an industry in the United States were associated with World War I. The coal tar industry had been largely neglected in the U. S. prior to this time, but munition orders flooding the country sent the price of benzene up from 40c to $1.25/gal., toluene to $4/gal. and phenol to $1.20/lb.

These fabulous prices touched off the wildest explosion of chemical activity this country had ever seen. By 1918 yearly production of toluene had risen to 22,000,000 gallons from a 2 to 4 million gal. prior to the war.

Three efforts were made to recover toluene from petroleum. Each was based on developments in thermal cracking which had shown that gasoline yield and quantity would be increased by cracking of crude oil fractions.

Dr. Walter Rittman of the Bureau of Mines proposed passing vapors of high boiling petroleum distillates through metallic tubes at a temperature of 500-575° C. and a pressure of 250-300 psi. This process was tried in an experimental plant at Pittsburgh but never operated successfully.

A similar method, using naphtha, known as the Hall Process, was more successfully operated on a small scale in 1918 at the Standard Oil plant in Bayonne.

The most successful effort, however, was made by the General Petroleum Co. on the West Coast who obtained a 6% yield of toluene by severely cracking a naphtha fraction. Two plants costing about $5,000,000 were built at Los Angeles and San Francisco with a total capacity of about 200-300 b/d but with the signing of the Armistice, they never achieved full production.

There are five possible routes for producing aromatics from petroleum:

1—Recovery from crude petroleum.
2—Dehydrogenation of naphthenes.
3—Ring closure of paraffins.
4—Cracking — polymerization — cyclization of aliphtatic hydrocarbons.
5—Alkylation of lower aromatics.

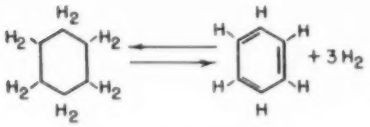
Aromatics may be recovered from crude fractions. Ordinarily, the concentration of native aromatics is low in crudes and direct recovery requires the expensive handling of large amounts of hydrocarbons. There were several plants, however, which were constructed during World War II for recovery of toluene from virgin naphtha. Today, processes for the dehydrogenation of naphthenes are the chief source of aromatics from petroleum. Several reports have been published on techniques for cyclizing or aromatizing paraffins using chromia catalysts, but no commercialization of this process has yet taken place. Cracking of higher molecular weight paraffins is typified by the Catarole Process wherein aromatics are produced by high temperature, low pressure cracking of gas oil. This process is currently operated in England but not in the U. S. The last process, alkylation of lower aromatics, is important in the production of compounds such as styrene and cumene.

In the quest for higher yields of better quality gasoline, several developments in petroleum refining have set the stage for large scale aromatics recovery from crude oil. Chief among these were processes for catalytic reforming of naphtha fractions. It had been shown even before World War I that palladium or platinum as a catalyst would promote reactions to convert naphthenes to aromatics. However, the earliest work, done at

300° C. and 1 atmosphere pressure, was marked by rapid and permanent deactivation of the catalyst.

Efforts to develop a selective catalyst which could be regenerated were finally culminated by the commercialization of the fixed bed Hydroforming Process using molybdena type catalysts at about the start of World War II. It may truly be said that this process marked the start of the modern "aromatics-from-petroleum" industry. Many companies, including the M. W. Kellogg Co., the Humble Oil and Refining Co., the Shell Development Co., the Standard Oil Development Co. and the Standard Oil Co. (Indiana), were also active in this work.

The chief reaction which may lead to aromatics production is as follows:



$$C_6H_{12} \longrightarrow C_6H_6 + 3H_2$$

$$\Delta H = +49 \text{ K CAL.}$$
$$\Delta G = 53,700 - 96.6\,T$$

This case leads to benzene although the same mechanism would form higher molecular weight aromatics from corresponding naphthenes. Relationships for free energy changes for the dehydrogenation of naphthene to aromatic indicate that, at usual hydroforming conditions of about 900-1000° F., equilibrium is overwhelmingly in favor of the aromatics. These conclusions are borne out by published data on relatively pure compounds[1].

The fixed bed Hydroforming process represents a compromise based on observations that carbonaceous deposits formed when producing aromatics at low pressure could be eliminated by carrying out the reaction in the presence of hydrogen. However, the required pressures were sufficiently high to reduce the degree of naphthene conversion. Therefore, sufficient hydrogen was used to drastically reduce carbon formation. Under these conditions, the molybdena type catalyst remains active for a relatively long period of time.

However, the process is cyclic, and at least two reactors are used to allow continuous feed processing since one reactor must be regenerated by blowing with an air-purge gas mixture to burn off deactivating carbon while the other reactor is on stream. The usual cycle will range from 8-16 hours duration as regulated by an automatic electric cycle controller. A net amount of hydrogen, about 800-1100 cu. ft./bbl.[2] of feed, depending upon hydroforming severity is produced. Because the dehydrogenation reaction is endothermic, hydroforming installations generally use two reactors with an intermediate reheating furnace. This is an added complication but economically justified.

Table 1—ASTM Standards, Aromatic Hydrocarbons

Product	Nitration Grade		
	Benzene	Toluene	Xylene
Dist. range, °C.	1	1	3
Acid wash color not darker than	2	2	6
Freezing pt., °C. ....>	4.85	..	..
Purity, %	99+	98+	96+

Although the initial impetus for hydroforming development had been octane improvement for motor gasoline, during World War II it was necessary to operate largely on a narrow-cut feed stock, preferably a C_7 cut or a narrow C_7-C_8 fraction to produce toluene and aviation gasoline blending agents.

The impetus given by toluene demand during the last war gave rise to the construction of 15 plants for this purpose, having a combined design capacity of 14,135 b/d which might be compared to about 2200 b/d available from coal tar.

Eighty-one per cent or 11,425 b/d of this capacity were based on hydroformate while only 19% or 2,710 b/d of capacity were based on virgin or cracked naphthas. It has been estimated[1] that production of all World War II TNT from virgin stock toluene would have demanded the processing of about one-third of the virgin naphtha produced in this country at that time. Hydroforming allowed large quantities of toluene to be recovered from only a fraction of the naphtha which would otherwise have had to be processed.

At the end of World War II, conditions similar to World War I existed in that demand for toluene dropped rapidly. Most of the hydroformers were either converted to naphtha quality improvement service or shutdown. One very interesting exception to this was the Baytown Ordnance Works, originally placed in operation in September 1941. This unit was purchased by the Humble Oil and Refining Co. several months after the war, and has operated continuously processing virgin naphtha for octane improvement, aviation blend stock production, and for the production of high purity solvents. Toluene (98-99% pure), xylene (98-99% aromaticity), a 95% C_9 aromatic fraction and a 90% C_{10} aromatic fraction are manufactured.

The period between World War II and the start of the Korean conflict was again one of development. Recognizing the limitations of the fixed bed Hydroforming process, several alternate processes have been offered to the industry.

These are: 1) Fluid Hydroforming, 2) Platforming, 3) Atlantic Catalytic Reforming (Catforming), 4) Cycloversion, 5) Hyperforming, 6) Houdiforming, and 7) Thermofor Catalytic Reforming.

With the successful use of the Fluid technique in catalytic cracking it became apparent that application to reforming held great promise. The continuous and flexible nature of a Fluid process coupled with nearly isothermal conditions are highly desirable features during aromatics synthesis. As noted above, a Fluid Hydroforming Process using a regenerable type catalyst has been successfully developed. A 2000 b/d unit has been built by Pan American Refining Co. at Destrehan, La. and plans have also been made to construct at least three larger units of this type with a total feed capacity of about 30,000 b/d.

Others of these commercial catalytic reforming processes utilize platinum as a catalyst in a fixed bed. Universal Oil Products and the Atlantic Refining Co. have announced processes using platinum catalyst under conditions where regeneration can be avoided. Under selected reaction conditions the catalyst can be used for extended periods of up to two years. Generally, deactivated catalyst is sold to reclaim platinum and a fresh charge is substituted.

The use of platinum catalyst has developed rapidly within the last two to three years. At the end of 1952, for example, there were 17 Platforming units in operation having a feed design capacity of 45,700 b/sd[6]. These figures do not include other platinum-catalyst-based capacities.

In general, each of the recent processes represent a combination of conditions aimed at selective conversion of naphthenes to aromatics to give improved operation over the original fixed bed Hydroforming Process of World War II. The petroleum industry has, therefore, developed improved techniques for gasoline improvement which have also furnished a method for obtaining tremendous quantities of aromatic hydrocarbons from petroleum. Egloff[7] has, for example, estimated that based on 1951 crude oil production in the U. S., 825,000,000 gals of benzene, 1,650,000,000 gals. of toluene and about 2,500,000,000 gals. of xylenes and ethylbenzene could be obtained by use of reforming catalysts.

Recovery Processes

In order to be useful for chemical processing, aromatic hydrocarbons must be essentially pure. Purities of 96-99% are generally specified (Table 1). The products have very narrow boiling ranges, and they contain

Table 2—Benzene-Hydrocarbon Azeotropes

Compound	Boiling point, °C.	Wt.-% of HC in azeotrope	Boiling pt., azeotrope, °C.
Methyl hexane	68.95	95	68.8
Methyl cyclopentane	71.8	90	71.4
Cyclohexane	80.75	45	77.5
2,2,3 trimethyl butane	80.8	49.5	76.6
2,4 dimethyl pentane	80.6	52.6	75.2
2,3 dimethyl pentane	89.8	20.5	79.2
Benzene	80.2	...	...

Table 3—Boiling points of Naphthenes and Corresponding Aromatics

Naphthene	B.P. °F.		Aromatic
Cyclohexane	177	176	Benzene
Methyl cyclohexane	213	231	Toluene
1,4 dimethyl cyclohexane	256	281	Para-xylene
1,2,3, trimethyl cyclohexane	293	349	1,2,3 TM Benzene

little or no other unsaturated materials as evidenced by the acid wash specifications.

Whereas in coal tar distillates purification of aromatics is a relatively simple process since essentially no other type compounds are present, petroleum distillates are a mixture of many hydrocarbon types. The aromatic content of a feed stock for aromatics production may range from as little as 10% to generally no more than 50-60%. It would be difficult, and probably impossible, to recover pure benzene from a moderately dilute feed stream by distillation alone due to the formation of azeotropes as shown in Table 2. The situation with regard to higher boiling aromatics is even more complicated in view of the increased number of hydrocarbon isomers present.

One classic approach to the problem, which incidentally formed the basis for the Rittman and other World War I processes, is to take advantage of the greater thermal stability of aromatics versus paraffins or naphthenes. It is feasible, although not generally economic, to crack severely an aromatic fraction as a means of concentration. Any close-boiling unsaturates may then be removed by acid treating.

The Catarole Process, as practiced in England is an example of this procedure. However, it should be noted that other by-products such as ethylene and propylene are obtained from this type process.

Other techniques for the large scale separation of "pure" aromatics were developed during World War II. One very interesting approach was to take advantage of an increase in boiling point in converting a naphthene to an aromatic.

For example, as shown on Table 3, converting a naphthene such as MCH to toluene results in an increase in BP of 18° F., for 1, 4 dimethylcyclohexane the change is 25° F. Thus, by proper feed fractionation, it is possible to produce highly concentrated aromatic fractions.

If a virgin naphtha feed were fractionated to remove all native xylene and close-boiling hydrocarbons but to include lower boiling xylene-formers, it would be anticipated that the xylene fraction of the hydroformate would be quite pure.

This was carried out at Baytown during World War II. Use of a closely fractionated 200-250° F. feed resulted in the production of a 95% pure "incidental" xylene fraction. Even when the end point was increased to 275° F., the purity of the xylene was still 90%. Up to 2500 b/d of xylene were produced thusly at Baytown during the war[3]. During postwar operation, a similar operation was used to obtain high purity C_9 and C_{10} aromatics by simple distillation alone.

A similar process for benzene, which has been suggested by the Shell Oil Co. in several patents, would involve fractionation of a C_6 cut to exclude benzene plus close boilers but to include MCP, followed by isomerization of MCP to CyC_6, refractionation to get a CyC_6 concentrate and hydroforming for the production of pure benzene.

Mention should also be made of the two-pass hydroforming process used by the Standard Oil Co. of California at their Richmond, Calif. plant for wartime toluene production.

In general, however, for a very large fraction of aromatics production, hydrocarbon mixtures must be handled for recovery. Methods which have been developed resort to modification of phase relationships so as to create circumstances selective to the separation of a desired material. They may be divided in four possible categories, i.e.: 1) Vapor-liquid systems, 2) Liquid-liquid systems, 3) Liquid-solid systems, and 4) Vapor-solid systems. Commercial applications of the first three techniques have been developed.

Vapor-Liquid Systems

Assuming that deviations from perfect gas law behavior are negligible, the vapor composition of a component Y can be related to its equilibrium liquid composition X as a function of pressure of the pure component at any desired temperature P, the total pressure π, and finally a term, γ, which is a measure of deviations of the liquid from ideal behavior. The term, γ, is generally referred to as "the activity coefficient."

(1) $\pi Y_1 = \gamma_1 X_1 P_1$

(2) $\pi Y_2 = \gamma_2 X_2 P_2$

(3) $(Y_1/Y_2)\ (X_2/X_1) = \alpha 12 = (\gamma_1 P_1)/(\gamma_2 P_2)$ or $\alpha_{nm} = (\gamma_n P_n)/(\gamma_m P_m)$

Generally speaking, as a component approaches 100% concentration its activity coefficient, as might be anticipated, approaches one. The condition for azeotropy is that in which the ratio of $\gamma_1 P_1$ to $\gamma_2 P_2$ is equal to one.

It was also recognized that by the addition of selected agents, it is possible to alter vapor liquid relationships in a desired fashion so as to obtain otherwise difficult or impractical separations. The use of benzene to dehydrate alcohol has been practiced for many years. An intensive investigation of such relationships has been reported in the literature[10]. As a rule, the addition of a polar hydrocarbon such as acids, alcohols, ethers, ketones, amines, phenols, esters, etc., were found to increase the relative volatility of a paraffin, naphthene or olefin to an aromatic.

Extractive and Azeotropic Distillation

Two processes, usually termed extractive distillation and azeotropic distillation utilize these principles to recover pure aromatics. In an extractive distillation process, shown schematically in Fig. 2, a solvent higher boiling than the feed is introduced near the top of the extraction tower. Hydrocarbon feed, carefully fractionated, is fed at a point below the solvent feed tray. Prefractionation of the feed should be emphasized.

Calling the ratio of the activity coefficients of nonaromatic to aromatic the "improvement factor," any nonaromatic whose vapor pressure ratio to the aromatic is the inverse of the improvement factor will act in the presence of the solvent as though it boiled at the same point and cannot therefore be separated in the extractive distillation process.

It may also be impossible to remove such a material by distillation of the crude aromatic due to azeotrope formation. In this connection, prefractionation of an aromatic in the presence of lower boiling hydrocarbons, which form minimum boiling azeotropes, is helpful for the extraction step since the aromatic tends to be concentrated in a normally lower boiling hydrocarbon fraction. In the extraction tower, hydrocarbon azeotrope is broken up and the normal volatility relationships increase the separation effect.

Returning to the flow diagram, note that a section above the solvent feed tray is provided to knock back solvent from the overhead. This is more difficult than indicated by the boiling points of solvent and hydro-

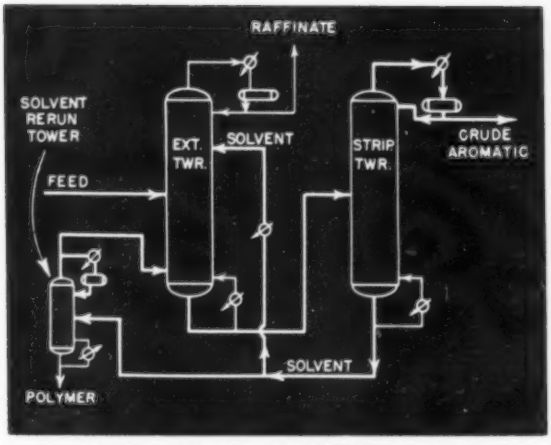


FIG. 2—Extractive distillation process

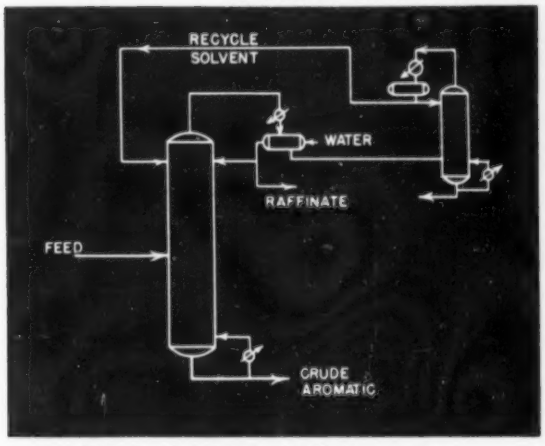


FIG. 3—Azeotropic distillation process

carbon due to the abnormal liquid phase characteristics of these mixtures.

Bottoms from the extraction tower containing aromatic plus solvent are fratcionated in a stripper tower to separate an aromatic product and to obtain recycle solvent which is recirculated to the extraction tower. A small portion of the solvent may be fed to a solvent rerun tower to remove polymers which tend to form by reaction of unsaturates in the feed with the solvent.

As solvent concentration increases in the extractive distillation tower, relative volatility enhancement increases. Also as reflux ratio increases, better separation occurs. However, in an extractive distillation tower operating at a given solvent feed rate, increasing the reflux ratio may improve separation for a certain range. However, the relative volatility is decreased and the point will eventually be reached where further reflux ratio increase will result in poorer separation. This point somewhat complicates control of the extraction tower. It may, by a similar line of reasoning, be shown that for a given separation an optimum exists where solvent circulation rates are a minimum.

This process was used extensively during World War II for the recovery of toluene and more recently for the recovery of benzene. Aniline, furfural, phenols and cresols may be used as solvents. Generally, the crude aromatic requires finishing steps, namely acid or clay treating and rerunning. These steps will be discussed later.

It is, however, possible to produce nitration grade products directly by extractive distillation provided the feed stocks contain little or no unsaturated aliphatics and provided very careful feed fractionation be employed. Overall recoveries of 90-95% and crude extract purities of 96-99% can be obtained by this process.

In some cases, especially if a relatively pure concentrate is available, it may be desirable to use a solvent generally called an entrainer, which will be carried overhead. Fig. 3 shows a simplified diagram for such a process.

Methanol and methyl ethyl ketone-water were used in two toluene recovery plants during World War II. These units were operated by Magnolia Petroleum Corp. at Beaumont, Texas, and Standard Oil Co. of California at Oleum, Calif., respectively.

Basically, the same principles discussed in extractive distillation apply to azeotropic distillation. The presence of a third component changes volatility relationships in a desired manner. In this case, however, the solvent is taken overhead with the raffinate as an azeotrope.

Heat requirements to vaporize the solvent will be high if the feed is dilute in aromatics. In addition, some means must be provided to break the hydrocarbon-solvent azeotrope. Techniques such as phase separation by cooling or water extraction followed by distillation of the water extract to recover recycle solvent may be used. One advantage of this technique over extractive distillation lies

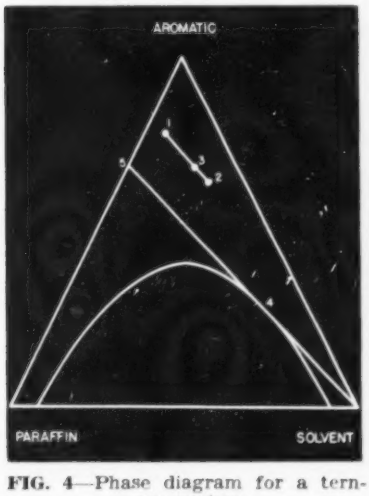


FIG. 4—Phase diagram for a ternary system

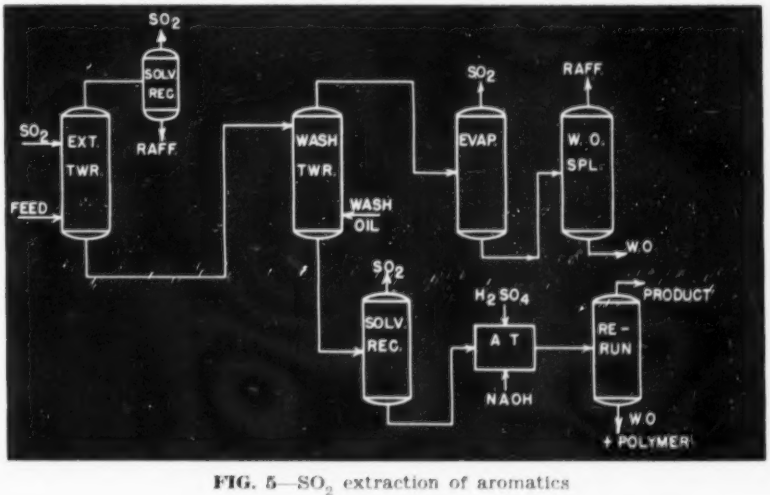


FIG. 5—SO_2 extraction of aromatics

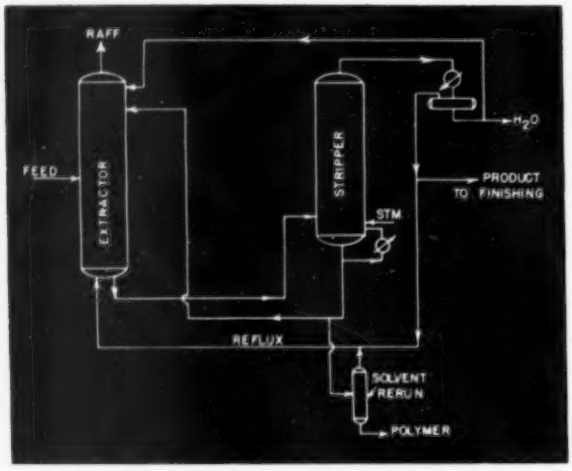


FIG. 6—UDEX extraction unit

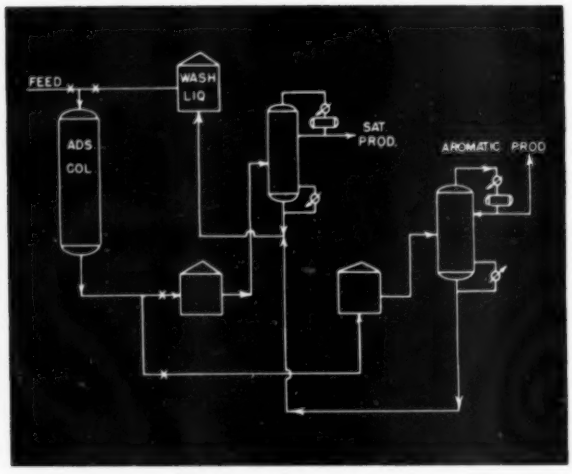


FIG. 7—Arosorb process

in the absence of a polymer or sludge problem in recycle solvent.

Liquid-Liquid Extraction

As an alternate to a liquid-vapor system, it is possible to separate aromatic-non-aromatic mixtures by providing for the presence of a second liquid phase which would be selective for either of the components.

The use of SO_2 was suggested at an early date when Edeleanu in 1907 described his process for refining kerosine by use of liquid SO_2 to extract aromatic compounds. During 1930 a continuous plant charging 7000 b/d of kerosine distillate was in operation. One plant, the Baytown Ordnance Works was the only plant which had adapted this process to recovery of pure aromatics[15]. An important problem is to overcome limitations in purity, as a result of phase relationships.

Fig. 4 depicts a typical aromatic (toluene), paraffin, solvent (SO_2) phase diagram.

The inverse lever rule states that, if mixtures 1 and 2 are mixed, the resulting composition will lie on a straight line between 1 and 2, i.e., pt. 3, whose distance from 1 will be determined by the relative quantities of 1 and 2.

By a similar reasoning it can be shown that the maximum purity extract will be that formed by the intersection of the line through the solvent point, tangent to the phase diagram, with the binary line aromatic-paraffin. To remove the remaining impurities, a second extraction or wash step can be employed to replace the lower boiling paraffins with heavy paraffins in the kerosine range.

Thus, fresh feed (see Fig. 5) is contacted with SO_2 liquid. The extract, containing 70-90% aromatic on a solvent free basis, is then washed with high boiling paraffins to remove the lower boiling non-aromatics. The remainder of the process involves those steps necessary to recover solvent, wash oil, raffinate and aromatic products from these mixtures. As might be anticipated, the cost of recovering solvent is an appreciable portion of the total operating cost of units of this type.

Another liquid-liquid process, the UDEX process, is shown in Fig. 6. The system is a conventional extractor-stripper combination. Feed need not be closely fractionated before extraction and several aromatics may be recovered simultaneously, as for example, benzene-toluene and xylene. Liquid-liquid systems have this advantage over extractive or azeotropic distillation.

A mixed glycol-water solvent is used in the UDEX process. The extraction tower is operated at a higher pressure than the stripper tower, the pressure being regulated so that the bottom of the stripper tower is at the same temperature as the extractor tower. This eliminates the costly heating and cooling of solvent which would otherwise be required.

In addition, it is possible to overstrip the recycle solvent and use the makeup water for solvent recovery from the raffinate phase. Furthermore, the solvent is noncorrosive, nontoxic and relatively stable and possesses good density differences. Another feature of this process is a special type tray design for the extractor. Details of this tray have not been disclosed.

The aromatic product may require acid or clay treating followed by fractionation to obtain individual aromatics.

This process has had very rapid commercialization and several units for the recovery of benzene, toluene and xylene are in operation or construction. High recoveries, 95-99%, at high purities, 96-99%, have been claimed.

Table 4—Benzene Recovery Facilities in the U.S.

	(million gal./yr.) ext. dist.	Udex	Arosorb
World War II converted units	42	..	..
New or planned	34	7.5	13
Totals	76	7.5	13

Overall total is 96.5, out of 130,000,000 gal./yr. planned capacity in 1955.

Solid-Liquid Process

The only commercialized example of this type process is Sun's Arosorb Process based on silica gel extraction[12]. It is the outgrowth of successful use of silica gel adsorption as an analytical method for separating organic compounds. In place of costly regeneration of the gel when saturated with aromatic, Sun uses a suitable desorbent which would leave the bed ready for charging after the desorption cycle. It has been possible to achieve this using another hydrocarbon, (preferably an aromatic concentrate) of different boiling range than the aromatic being recovered. Despite the fact that the aromatic being recovered may be adsorbed more strongly than the desorbent liquid, it can be removed since its concentration is zero in the desorbent phase.

The scheme used is a cyclic operation, as shown in Fig. 7. The charge is fed to the adsorber until the gel is perhaps 50-70% saturated. At this point, desorbent is added, and feed is cut off. The effluent from the column first consists of charge non-aromatic plus desorbent, then aromatic plus desorbent. An intermediate band may be recycled to the feed if necessary. By simple distillation the feed aromatic and non-aromatic can be readily separated from desorbent which is recycled.

Care must be taken to protect the gel from deactivation. This means careful drying of feed and removal of other gel poisons. In addition, the problems generally associated with

fixed beds, namely, intermittent operation and liquid distribution are also present. A very interesting advantage is that a silica gel process could be used to recover aromatics over a very wide range of molecular weights.

Comparison of Processes

Published data indicates that by 1955, 130,000,000 gals./yr. of benzene will be produced from petroleum. Information on the techniques to be used for the recovery of 96,500,000 gals./yr. of this total is also available and is summarized in Table 4.

It is more difficult to pick out similar figures for toluene. The Baytown SO_2 unit with its wartime capacity of 72,000,000 gals./yr. (4700 b/d) of aromatics produces substantial amounts of extracted toluene, and an additional 10 to 20,000,000 gals. of new extraction equipment has been announced.

Finishing Operations

Finishing operations are necessary before extracted aromatics can be brought up to specifications. In particular, the acid wash specification is difficult to meet. Dunn and Leedholm[13] have shown that as little as 2/1000 vol.-% of cyclopentadiene, 1/100% methyl pentadiene, or 0.1 vol.-% of cyclohexene can be tolerated for an acid wash color specification of 2.

Generally, it is necessary to take crude aromatic, treat with sulfuric acid and caustic wash and rerun to insure meeting acid wash specifications. The type and severity of treatment depends on source material. Aromatics from virgin stocks need little if any treatment while cracked feed stocks yield crude aromatics which may require 98% H_2SO_4 treats of 20-30 lb./bbl. Considerations of contacting efficiency, reaction temperature and sludge settling characteristics are important to keep aromatic losses during finishing at a minimum.

Separating Aromatic Isomers

Recovery of benzene or toluene results in the production of a product of sufficient purity to be suitable for chemical processing. In the case of C_8+ aromatics, however, the presence of isomers complicates this picture. For example, so-called "nitration grade" xylene is a mixture of several isomers. For the manufacture of chemicals such as Dacron, phthalic anhydride and styrene, pure isomers are required.

In 1951, fully 85% of the 75,660,000 gals. of refined mixed xylenes produced in the U. S. came from petroleum.

Ortho-Xylene

Ortho-xylene can be obtained from solvent xylenes by superfractionation.

Table 5—Physical Properties of C_8 Aromatics

Compound	b.p. °F.	Freezing pt., °F.	Ratio in reformate
Ethylbenzene	277.1	−138.9	20
Para-xylene	281.0	+ 55.9	17
Meta-xylene	282.4	+ 54.2	43
Ortho-xylene	**292.0**	− 13.3	20

Table 5 shows physical properties of the four C_8 aromatic isomers. In any xylene concentrate it is obvious that the higher boiling ortho-xylene isomer can be concentrated by distillation. Ortho-xylene, when oxidized, gives phthalic anhydride and, hence, can be used in place of naphthalene. (See discussion below.)

At least one petroleum company, Oronite, is producing ortho-xylene for conversion to anhydride by this method. As designed in 1945, this plant had a capacity of 3500-4000 tons/yr. of anhydride.

Although the theoretical yield from ortho-xylene exceeds that from naphthalene, in actual practice about 80-85% of the yield from naphthalene is obtained. Other petroleum companies have, from time to time, offered ortho-xylene for sale. It has been estimated that at least three producers could make 50,000,000 lbs./yr. of anhydride from ortho-xylene on short notice if the raw material were available at an attractive price.

Para-Xylene

Referring again to Table 5, para-xylene has a much higher freezing point than the other xylenes. Recovery by crystallization is a very evident choice. This material is in demand for Dacron processing by conversion to terephthalic acid. The Humble Oil & Refining Co. has announced plans to supply 25,000,000 lbs./yr. from a new plant at Baytown, Texas scheduled for operation in mid 1953. In addition, Oronite has been supplying some para-xylene for Dacron manufacture during the past several years. A two-stage crystallization process to boost purity from the xylene mixture to 95% has been suggested. Removal of ortho-xylene gives a higher concentration of para-xylene in the crystallization feed with attendant simplification and improvement of recovery and purity.

Meta-Xylene and Ethyl Benzene

Meta-xylene has been suggested as a feed stock for isophthalic acid production. However, no large scale uses have developed. Ethyl benzene for styrene manufacture is a distinct possibility but recovery of the necessary purity has not been economic to date.

Naphthalene

Today, large quantities of naphthalene are converted into phthalic anhydride by oxidation in the presence of a suitable catalyst. The market for naphthalene resembles somewhat that for benzene in that production is tied to coal coking operations. Following the pattern for benzene, petroleum might be used as a base for additional supplies since chemical demand may soon outstrip recoverable quantities from coal.

In some respects, however, the naphthalene pinch is not so tight as that for benzene.

However, in the long run it is clear that either naphthalene or naphthalene substitutes must be produced in even larger quantities in the future. The 1975 requirement has been estimated at 3,720,000,000 lbs./yr., a 7-fold expansion over even the 1955

Meet the Author

Dr. Maisel

Daniel S. Maisel joined the Standard Oil Development Co. in 1948 as a member of the Development Division. He is engaged in the engineering development of new projects relating to the recovery and manufacture of chemicals from petroleum.

Dr. Maisel's educational background has been wholly in chemical engineering. He received his B. S. from Carnegie Institute of Technology in 1941, his M. S. and Sc. D. from Massachusetts Institute of Technology in 1947 and 1948. Prior to joining S. O. D., he had been associated with du Pont and with MIT as an instructor in the chemical engineering department.

Dr. Maisel is a member of the American Chemical Society and the American Institute of Chemical Engineers. His previous publications have been in *Chemical Engineering Progress* and the *Trans. Am. Inst. Mech. Engrs.* on fundamental studies on interphase mass and heat transfer relationships.

figure. Naphthalene recovery from petroleum has not yet been attractive.

The boiling point of naphthalene (420° F.) places it outside most reformate ranges. Hence, the reformates contain relatively little naphthalene. Presumably large amounts of naphthalene are found in catalytic heating oil at dilute concentrations. Although the petroleum industry has probably looked at naphthalene recovery, there has not been a sufficient incentive for commercialization of recovery methods.

Perhaps coal hydrogenation may supply additional naphthalene in the future. Methyl naphthalene is another good possibility.

Higher Molecular Weight Aramotics

In the field of aromatic separation; benzene, toluene, and some xylenes or naphthalenes have been segregated in large quantities for commercial processes. However, other C_9 and C_{10} aromatics have been of interest in recent research and development studies. It is also reasonably certain that if any appreciable demand develops, separation of the pure compounds from reformed stock is a definite possibility.

Present information indicates that methylethylbenzene or trimethylbenzenes can be isolated in relatively high concentration by distillation. Durene (1, 2, 4, 5 tetramethyl benzene) can be recovered by crystallization. Large quantities of indan (2, 3 dehydro-indene) methyl-indan, isodurene, etc., are also available in reformed stocks. No commercial separation of these materials has been disclosed, but they also remain interesting possibilities.

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Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Trichlorophenol and Trichlorophenoxy Acetic Acid

TRICHLOROPHENOL, pronounced "try-*klo*-row-*fee*-noll," and its derivative, **TRICHLOROPHENOXY ACETIC ACID,** pronounced "try-*klo*-row-*feh*-nox-ee ah-*see*-tik *ass*-id," are petrochemicals by virtue of their derivation via intermediates from benzene, which is now being extensively produced from petroleum via catalytic reforming of naphthas. In both cases, what is known as the 2,4,5-trichloro-isomer is the one of specific interest; it is from this fact that the latter chemical derives its commercial name of 2,4,5-T. Incidentally, isomers are chemicals having the same number and kind of atoms in their molecules, but in different arrangements; for example, there is a 2,4,6-trichlorophenol.

Having the formulas $Cl_3C_6H_2OH$ and $Cl_3C_6H_2OCH_2COOH$, respectively, these chemicals are solids which can be dissolved in commercial solvents. 2,4,5-Trichlorophenol is of commercial interest as a fungicide; it can be used to protect textiles, leather, and glue against bacterial decomposition, molds, and decay. 2,4,5-T, in turn, is finding an increasing market as a herbicide — a killer of weeds and woody plants. Formulations containing this acid or its esters are effective against mesquite, poison ivy, poison oak, barberry, and brambles.

One method of obtaining both petrochemicals is the cracking of the "waste" isomers (those without insecticidal value) produced in the extraction of lindane (the gamma isomer) from commercial benzene hexachloride (itself an insecticide as a mixture of isomers, due to its lindane content). This produces, among other compounds, 1,2,4-trichlorobenzene, which can be reacted with chlorine to yield 1,2,4,5-tetrachlorobenzene. In turn, this can be hydrolyzed (reacted with water) to yield 2,4,5-trichlorophenol. To obtain 2,4,5-T, finally, the sodium salt of the phenol is reacted with chloroacetic acid.

These new fungicides and herbicides are important enough to warrant such multi-step syntheses, especially since the above-mentioned series makes another process (lindane extraction) more economic. They are another reason why the demand for petroleum-derived benzene continues to increase.

N-Butanol

n-BUTANOL, also called normal butyl alcohol, is today a true petrochemical, since its former method of synthesis—fermentation of agricultural materials—no longer controls the market. Pronounced "n-*beu*-tah-noll," it is a water-white liquid, with a wine-like odor, slightly lighter than water in unit weight, which freezes far below the freezing point of water and boils at a temperature slightly above it. Its formula is $CH_3CH_2CH_2CH_2OH$, and it has long been a basic industrial solvent and a raw material for other solvents and plasticizers.

The usual commercial synthesis of n-butanol is based on acetaldehyde (CH_3CHO), which itself is currently being produced from ethyl alcohol (from petroleum ethylene), by oxidation of LPG, or from acetylene (produced by pyrolysis or partial oxidation of natural or refinery gases). Two molecules of acetaldehyde are condensed to form aldol, which is then dehydrated to crotonaldehyde; the latter is hydrogenated to yield the alcohol. This substance is also produced as a co-product in the oxidation of LPG and as a by-product in the Synthine (Fischer-Tropsch) synthesis of gasoline from natural gas or coal.

n-Butanol and its chief derivative, n-butyl acetate, find their main use as solvents for lacquers, resins, and countless materials. Other important derivatives include dibutyl phthalate, other plasticizers, and "butylated" urea and melamine resins. Quantities are also employed in other chemical syntheses.

While the 1953 production of n-butanol may not exceed the 1944 output, 80% of it will be synthetic instead of the 25% produced in the earlier year. n-Butanol may not face a greatly expanding market, for it competes with other solvents and plasticizer materials, but its synthesizers have been able to take advantage of fairly steady, low material costs to drive from the market fermentation butanol manufacturers, who use high-priced corn and molasses. Here again, petroleum as a chemical raw material is taking over a field formerly dominated by another source.

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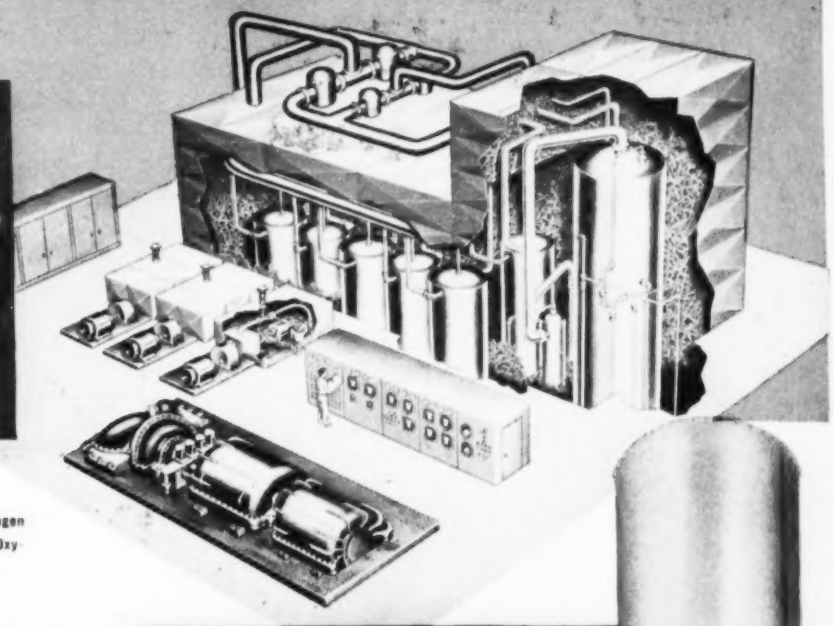

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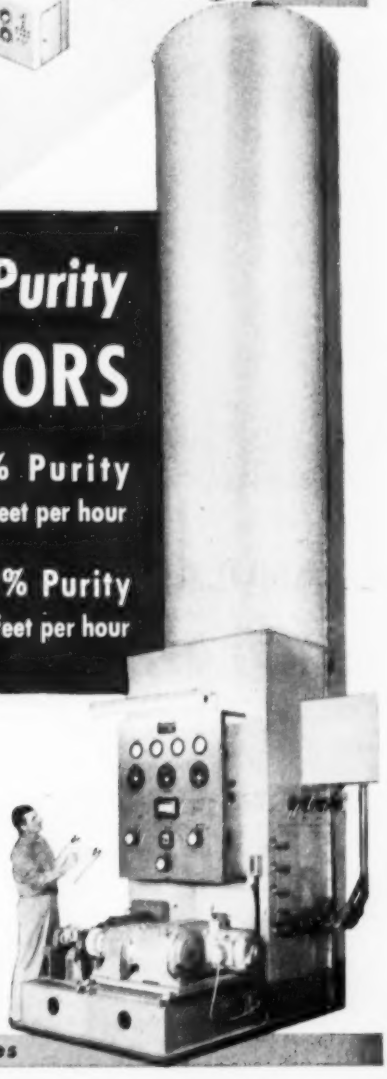

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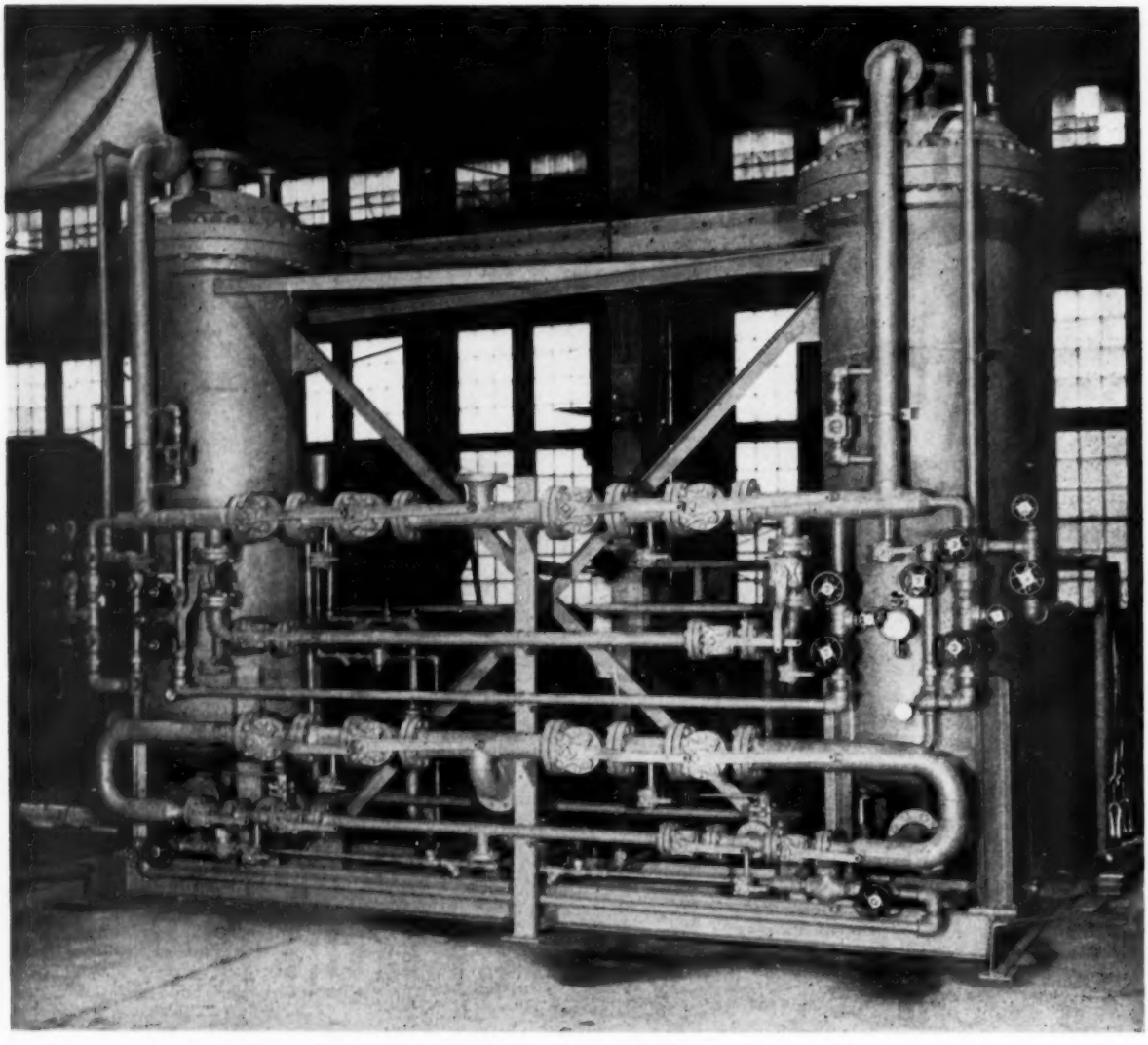

LIQUID XYLOL DRYER capable of handling 96 gpm at 135 psig and 100° F., uses activated alumina as a desiccant

GRANULAR DESICCANTS FOR *Drying Liquids by Adsorption*

By WESTON E. SMITH, C. M. Kemp Mfg. Co. and MAX LEVA, Consulting Engineer

USE of solid adsorbents, such as granular desiccants, offers an economic method for removing water from liquid hydrocarbons where high purity is desired and water content is relatively low. It is of particular value for many organic liquids in the petrochemical industry.

Among liquids which can be dried with good results are: benzene, toluene, xylene, cyclohexane, butane, propane, trichlorethylene, freon 11 and 12, methyl chloride. To this list may be aded many others, such as pentane and straight-chain hydrocarbons through the gasoline, kerosine range, on up to lube oil, and including animal and vegetable oils.

Moderate success has been obtained with the esters, such as ethyl acetate, butyl acetate, some alcohols, and pyridine. Liquids such as acetone, alkyl halides, acetyl halides and ammonia may not at present be dried by solid adsorbents.

It should not be stated categorically that this latter class of liquids will *never* be dried by solid adsorbents. There is considerable evidence that the results of a drying installation are quite dependent upon the kind of adsorbent used. Present-day knowledge of the mechanism of liquid drying by adsorption is not sufficiently complete to make definite recommendations so far as this liquid class is concerned.

When we speak of "liquid drying" we are exclusively concerned with the removal of relatively small quantities of water from liquids that are usually of the organic type.

In many organic liquids water is infinitely soluble; that is, their water content may vary from a trace to almost 100%. Examples are some of the alcohols, acids, acetone, and others. Regardless of temperature, these liquids when mixed with any quantity of water will appear entirely clear and the water will not separate, regardless of how low a temperature we may consider.

In contrast, there are by far more organic liquids in which water is only sparingly soluble; moreover, the water solubility will depend on temperature—being higher at high and lower at low temperatures.

At a definite temperature, therefore, an organic liquid may be saturated with water, and if we lower the temperature, some of the water will separate out and will eventually form a separate layer. When this happens we are accustomed to say that we have two separate phases, a water phase and a liquid phase. The latter is actually a solution phase since it still contains some (though less now) water dissolved.

These conditions are clearly indicated in Fig. 1, where sketch "A" represents a liquid of certain water content. Referring to Fig. 2; as we lower the temperature along path "A-B", we finally arrive at the water solubility curve (point "B") and at this stage water will begin to separate as a cloud.

Upon still further lowering the temperature, we follow along the course of the water solubility curve and may arrive at a point "C" where sufficient water has separated, to consolidate into a second phase.

As seen in Fig. 2, the temperature at which water separates from the solution in the form of a cloud is strictly analogous to the temperature at which moisture will separate out from the gas saturated with water vapor. In the latter case, we call this the dew point. When speaking of liquid systems, we call the dewpoint the "cloud point".

Returning to the definition of liquid drying, it does not matter whether relatively small amounts of water are removed from a liquid which will dissolve water in all proportions or from another that will only permit a sparing solubility.

When substantial quantities of water are removed from a liquid, the operation is no longer a drying operation. In these cases it is usually accompanied by distillation or evaporation. With relatively large quantities of water to be removed, the investment in adsorbent and equipment would soon become excessively high and render water removal by adsorption uneconomical. For this reason, liquid drying is not at all competitive with these other methods of dehydration as long as the water content of the liquids to be dried is high.

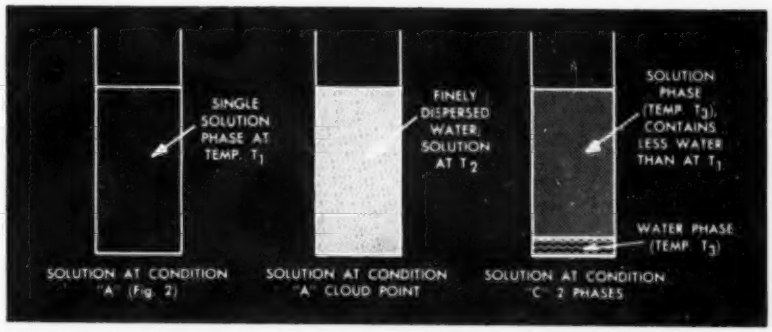
SINGLE SOLUTION PHASE AT TEMP. T_1
FINELY DISPERSED WATER SOLUTION AT T_2
SOLUTION PHASE (TEMP. T_3), CONTAINS LESS WATER THAN AT T_1
WATER PHASE (TEMP. T_3)
SOLUTION AT CONDITION "A" (Fig. 2)
SOLUTION AT CONDITION "A" CLOUD POINT
SOLUTION AT CONDITION "C" 2 PHASES

FIG. 1—Solubility relationship of water in liquid, with respect to temperature, cloud point, and separation into separate phases

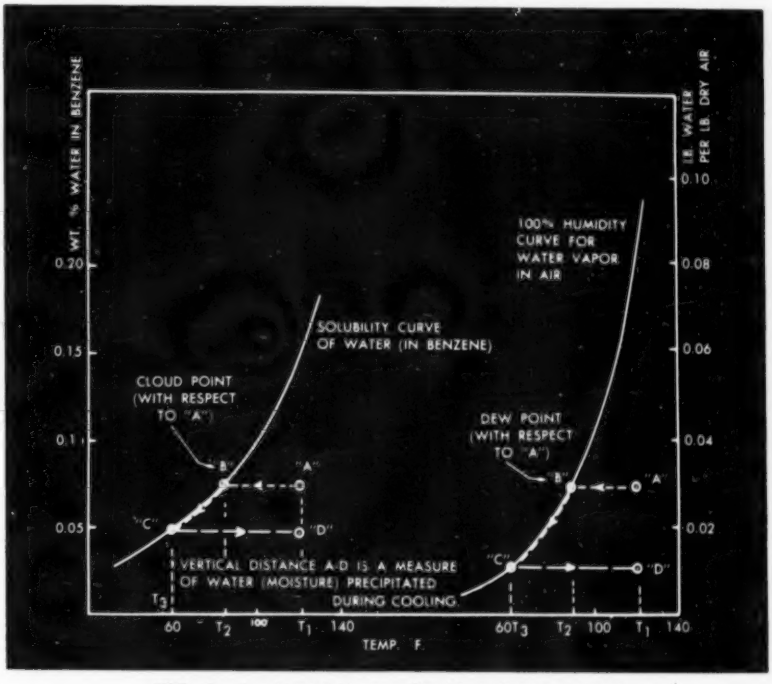

FIG. 2—Analogy between liquid and gas drying

When the water content is small, however, liquid drying is in competition with distillation and in most cases the economics favor liquid drying. Consider, for example, the removal of small amounts of water from benzene. If this were done by straight distillation—since benzene boils at a lower temperature than water—it would be necessary to evaporate the great bulk of benzene to render it anhydrous.

This would require a large amount of heat and considerable heat transfer—and condensing surfaces. In practice, where such a case prevails, a third component is usually added to the system that modifies the volatility relationships. Whereas this usually will save heat, it necessitates additional equipment to separate the third component from the system. It is in such cases where liquid drying represents a distinct saving.

How Much Water Is Removed?

A few typical water solubility data in some organic liquids are given in Fig. 3. These curves represent conditions of water content and temperature at which the liquids are always saturated.

Considering for instance benzene, we find that it is capable of holding 0.15% of water at 120°F.; whereas, at 60°F. it can hold only 0.05%. If we start with a saturated solution at 120°F. and slowly cool it to 60°F. water will, therefore, precipitate out and the solution will eventually clear up when the water has settled out.

Continuing, and considering one

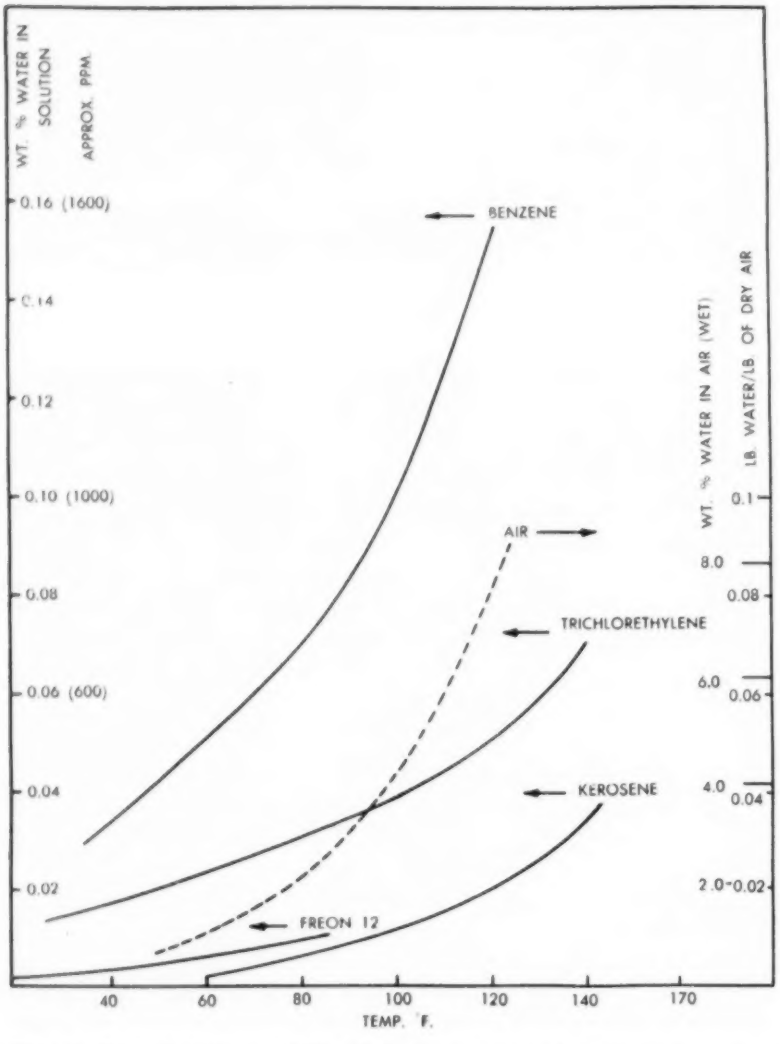

FIG. 3—Typical water solubility data in organic liquids, in comparison to humid air

cu. ft. of the liquid saturated at 120° F., this will weigh about 55 lb., of which 0.0825 lbs. represents water and 54.9175 lbs. anhydrous benzene. At 60° F. this quantity of benzene can hold only 0.0275 lb. of water and, therefore, by cooling we are removing 0.0825-0.0275 = 0.0550 lb. of water.

Comparing this with air saturated at 120° F. and cooled to 60° F., we would find that from one cu. ft. of saturated air we would remove only about 0.00525 lb. of water. Thus, on a volume basis, it would appear that more water is being removed from the liquid. On a weight basis, however, the reverse is true. Fig. 3 shows clearly that the water holding capacity of air is considerably greater than that of organic liquids.

Solubility data are most frequently expressed in parts per million (ppm) of the anhydrous liquid. Thus a water content of, say, 0.1% is very nearly equal to 1000 ppm.

It is of interest to point out that in liquids in which water is infinitely soluble we do not have a cloud point at ordinary conditions of concentration.

This situation does seem different from the gas-water vapor system. In reality it is not, however, as could be shown from considerations of the total pressure. Nevertheless, for our practical considerations we must speak in terms of ppm only and not cloud points when we consider liquids which will dissolve water in all proportions.

Why Dry Liquid?

There are many reasons for drying liquids. Some of the more important ones are listed below.

Corrosion: Water has been recognized as the cause of corrosion in pipelines which carry gasoline and other hydrocarbons. Owing to temperature changes, water will precipitate out and cause severe pitting and scale formation. This action is especially pronounced in presence of small quantities of air. The scale will collect in and near bends and seriously reduce the efficiency of the line. Corrosion is also a frequent trouble in refrigerant systems, where freon and methyl chloride is used. The trouble may be overcome by dehydration of the liquid.

Freeze-Ups: Small amounts of water in hydrocarbons such as gasoline, compressed gases such as propane, butane, etc.; and refrigerants like freon and methyl chloride may lead to difficulties due to line freeze-ups.

Chemical reactivity of water: Water, being chemically very active in some instances, will interfere with numerous chemical reactions. Toluene, used for nitration should contain less than 10 ppm of water. Another example is the alkylation of ethylbenzene, which must be dried very carefully if the alkylation catalyst, in this case $AlCl_3$, is not to be hydrolyzed and rendered ineffective. Anhydrous hydrocarbons are also needed for the production of synthetic rubber.

Water in solvents: Solvents that contain small amounts of water are definitely inferior to dry solvents. Solvents when used in enamels must be carefully dried if "blushing" of the surfaces is to be avoided.

Lube and transformer oil: It has been observed that the lubricating qualities of lube oils are seriously impaired when the oil contains small traces of dissolved water. The dissolved water will affect the surface tension and materially reduce the film strength, which is reflected in increased engine wear. Oil drying is well justified. Oils are also used in transformers. Presence of dissolved water decreases the dielectric constant, causing current leaks. Presence of dissolved water also causes gum formation which may be prevented by oil drying.

Which Liquids May Be Dried?

Generally, it may be stated that all liquids which fulfill the following three requirements may be dried by solid adsorbents:

1. No chemical reaction must occur between liquid and adsorbent, and thereby either consume or modify the adsorbent. (Example: strong acids and alumina.)

2. The liquid must not contain such

groups in its molecule that are adsorbed, preferentially to water. (Example: many alcohols, containing the OH group).

3. The liquid must be free of foreign constituents that will either block or "poison" the active surface. (Example: sulfur compounds with free air.)

Specific examples of liquids which may be dried were given above. Effluent water content in the dried liquid will depend on the type of adsorbent used and the contact time between liquid and solid, which is dependent on the design of the equipment. Experience has shown that the following limiting moisture contents may be reached quite easily: gasoline—30 ppm, toluene—10 ppm, benzene—4 ppm, naphtha—2-4 ppm, propane—10 ppm, freons—10 ppm.

It is interesting to examine how moisture will influence some of the refrigerants in use. This is shown below:

Refrigerant	H_2O, ppm	Effect on Equipment
SO_2	300	slight discoloration
	1000	slight scale
	1500	heavy scale
Methyl Chloride	200	slight discoloration
SO_2	300	marked discoloration
	500	moderate to heavy corrosion

The following tabulation lists the permissible moisture content of refrigerants for various operations:

Refrigerant	H_2O, ppm	Type of System
Freon 12	26-27	large commercial
Freon 12	20-30	large commercial
Freon 12	20-30	hermetic
Freon 12	37	domestic hermetic
Methyl chloride	50-70	small commercial

Adsorbents Presently Used

There are a large number of materials that may be used for liquid drying. The more important are: activated alumina, silica gel, florite, activated bauxite.

In addition, there are many inorganic salts that will take up water to form hydrates. There is a basic difference between the above materials and anhydrous salts. By virtue of their action the above are true adsorbents; whereas, the salts are actually absorbents. Adsorbents will function on the basis of their surface area; whereas, the salts will bind water more in a chemical sense. They are generally not used in liquid drying. Basic requirements of a liquid drying adsorbent are:

1. It must permit frequent regeneration without significant activity loss.

This requirement is obvious, since liquid dryers are dual units with one on adsorption while the other is being regenerated.

2. The granules must be hard, form no fines, and must not swell when they become saturated with water.

This is also a necessity as otherwise the flow resistance would increase in the bed. Furthermore, with the formation of fines, losses would be incurred.

3. The adsorbent should work rapidly and have a high water absorbing capacity.

This will give rise to small compact units.

4. The adsorbent must be cheap, as it constitutes an important part of the investment.

Probably the most frequently used adsorbent in liquid drying is activated alumina. Florite and bauxite are used extensively in large gasoline drying installations.

The drying efficiency of the adsorbent is clearly dependent on its water content. Thus an activated alumina which contains, say, 15% by weight of water will dry gasoline at best only to 100 ppm; whereas, the same alumina with but 9% of water will reduce the effluent moisture content to 10 ppm. These relative relationships are specific examples of what is known as the equilibrium which exists between adsorbent and the wet liquid as far as water content is concerned.

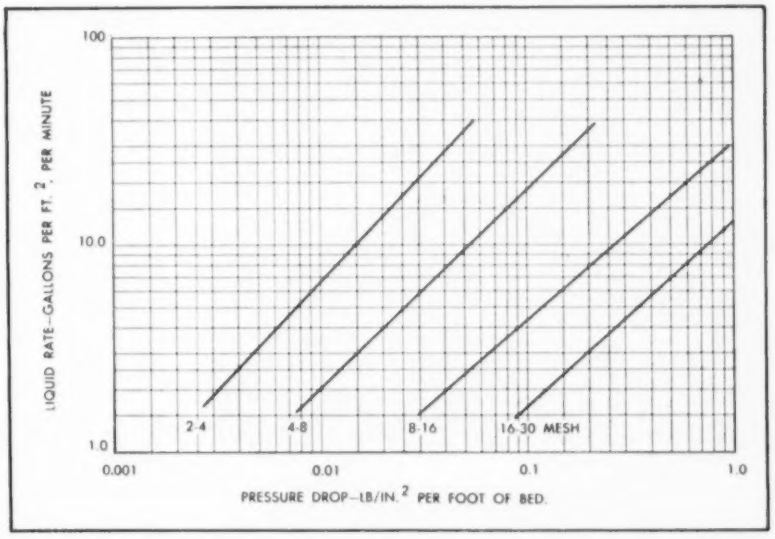

FIG. 4—Pressure drop of an organic solvent (sp. gr. 0.772) through beds of granules of various mesh sizes

Pressure Drop

The adsorbent type desiccant dryer is a dual unit. While one unit is on adsorption, the other is being regenerated. The activated alumina granule size varies between 4 to 20 mesh and the downward flow rate ranges generally from 10-15 gals./sq. ft./min. Somewhat lower flowrates are advisable for upward flow designs.

Pressure drops experienced are indicated in Fig. 4. Thus, for instance, for a flow of 20 gpm./ft.² through 8-16 mesh alumina, a pressure drop of 0.65 psi/ft. of bed would be experienced. If we have a tower of 1 sq. ft. cross-section, packed 10 ft. high, we would circulate a total of 2.67 ft.³/min. The theoretical horsepower will then be: $(2.67 \times 0.65 \times 10 \times 144)/33{,}000 = 0.076$. With as low a mechanical efficiency as say 50%, merely about 0.15 hp is then needed representing a very low pumping cost.

Adsorption and Regeneration

Suppose that during the adsorption cycle the wet liquid passes down through the adsorbent bed; the effluent moisture content will remain essentially at a very low and constant value. At the same time the adsorbent is gradually being saturated in zones moving slowly from the top down.

Thus, the adsorbent bed as a whole, after some time of operation, is not at a uniform moisture content. Sooner or later the bottom layer of the adsorbent will have reached a certain water content such that the effluent water content will have to rise. This point in the history of operation of the adsorbent is known as the break point and it indicates that the desiccant approaches saturation.

Exactly when, for a given flow, the break point will occur depends on the design of the equipment and principally on the flow rate relative to adsorbent quantity used and, of course, the initial water content of the liquid. The unit is then switched on regeneration.

Regeneration procedures are not

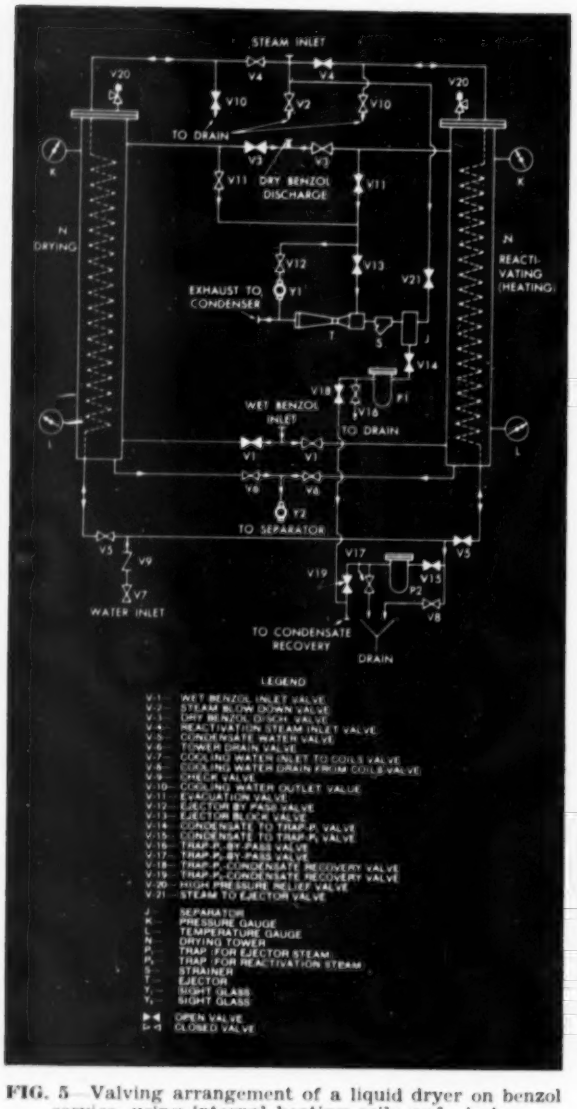

FIG. 5—Valving arrangement of a liquid dryer on benzol service, using internal heating coils and ejector

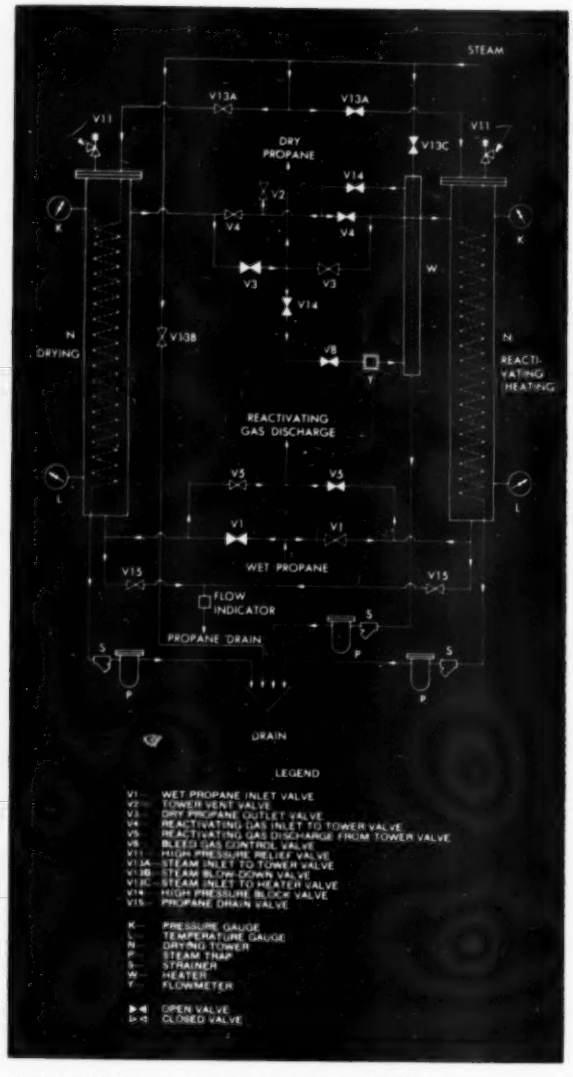

FIG. 6—Valving arrangement of a liquid propane dryer, reactivated by internal heating coils and bleed gas

entirely standardized, but usually they comprise all or most of the following steps:

1—Draining of tower.

2—Heating and evacuation of tower.

3—Passage of atmospheric air (sweep air) through adsorbent.

4—Cooling and evacuation.

The entire time required for regeneration will depend on the design and may vary from 6-12 hrs.

Temperature and heat requirements are of interest. If air or a dry inert gas is used for reactivation, its inlet temperature may vary from 350°-450° F. All adsorbents, with silica gel excepted, may be heated to 600° F. or above without permanently injuring the adsorbent.

The heat needed for reactivation depends, of course, to some extent on the thoroughness with which the tower was drained. In general, the heat required is the sensible heat for raising the tower, desiccant, and remaining liquid to the boiling temperature. Thereafter, the latent heat must be supplied—in additon to heat losses, of course, the heat of desorption of water away from the adsorbent is of minor importance.

Designs

At the present time there are three principal types of dryers for liquid service. Two of these are of the embedded coil design and are suitable only for steam reactivation. The third type employs an external reactivating system and can be designed for electric or steam reactivation.

The three types are discussed below:

1—Embedded coil dryers using steam jet ejector. The flow diagram, Fig. 5, shows a typical valving arrangement for this style of dryer.

As with all embedded coil machines, the towers are equipped with flanged heads to permit removal of the internal coils. Two-way valves permit maximum flexibility of operation for manual or semi-automatic control. Full automatic operation for liquid service, wherein multi-port valves may be used, requires special consideration and is not generally justified from a cost standpoint.

Valves, vessels, and piping must be designed to meet the requirements

of the service. Most applications are for low pressure, wherein 50 psig ASME Code design is acceptable. For propane service in particular, steel valves and fittings are used—the overall design being, for example, 300 psig., API-ASME Code.

The distinguishing feature of this type of dryer is the use of a steam jet ejector to evacuate a tower during the heating period of reactivation. By using the ejector, vaporized residual product and desorbed water can be safely withdrawn from the heated tower without the use of an external supply of purge gas. The ejector may also be used toward the end of a reactivation to draw a small amount of atmospheric air or inert gas through the tower to provide more complete reactivation of the desiccant.

A typical reactivation cycle as already outlined would require about 8 hrs.

Many liquids handled have low enough vapor pressure so that the desiccant can be cooled by radiation and finally quenched at the time of filling without generating excessive vapors. Materials as light as gasoline can be handled in this manner. By using this method of cooling, water for the internal coils can be eliminated.

The chief disadvantage of the ejector type machine is the relatively large steam consumption for evacuation. In the small machines steam for the ejector exceeds that for heating; in the large machines, the ejector steam is less significant.

The popularity of the embedded coil—ejector type of liquid dryer is no doubt due to its relative simplicity of design and reliability.

2—Embedded coil dryers using bleed gas. The flow diagram, Fig. 6, illustrates the valving arrangement for this style of dryer. It is quite similar to the previous one, differing only in the method of removing vaporized residual product and desorbed water.

Instead of the ejector, a stream of bleed gas must be available at a few pounds pressure to pass through the tower only during the heating period. The effluent bleed gas can be cooled and recovered if desired. Best reactivation results are obtained if dry gas is used or if moist gas at elevated pressure is expanded for use in the tower—which amounts to the same thing.

This style of dryer has the advantage of low steam consumption and simplicity of design. It does not always accomplish as thorough reactivation as style (1). Further, it is not always convenient to supply bleed gas and provide means for disposing of it.

3—Radiation or convection cooled dryers using external reactivation system. These dryers have been developed chiefly for handling liquid refrigerants such as Freon 11, Freon 12, and methylene chloride.

Reactivation is accomplished by passing air or gas at atmospheric pressure past a heater and thence through the tower. The heat is cut off after the water has been driven out of the desiccant and the dryer allowed to cool by radiation; or by recirculation of the reactivation gas through an external cooler in order to cool by convection.

The heater is located externally to the drying tower and may be electric or steam.

Summary

The foregoing report has presented basic concepts such as solubility, dew point, cloud point, etc. commonly encountered in liquid drying. The relationship and analogy between gas and liquid drying is stressed. In general it appears that on a weight basis the water holding capacity of gases is greater than that of those organic liquids which dissolve water only sparingly.

In adsorptive type liquid drying utility requirements are relatively low, especially when compared to the high utility loads attending distillation under high reflux. Residual water concentrations of 2 to 4 ppm. in hydrocarbon oils and other organics are not uncommon. These are concentrations that may ordinarily be obtained only with difficulty when other separation operations are resorted to.

Some of the reasons for liquid drying are indicated, and general adsorbent properties are discussed. A considerable number of liquids lend themselves to drying. Liquid drying seems to be a selective operation, and it appears that certain classes of liquids are treated best with specific adsorbents. The general properties of adsorbents in relation to liquid properties may well constitute the key to optimum design. From a mechanical point of view, liquid dryers are characterized by low pressure drops and power cost.

Finally, the paper describes the adsorption-regeneration cycle in the dual-type unit, and presents design details of proven standard installations.

Meet the Authors

Weston E. Smith, process and sales engineer, C. M. Kemp. Mfg. Co. Baltimore, has been associated with that firm since 1946. Prior to that he was with Socony-Vacuum Oil Co. for five years. A 1940 graduate of the University of Michigan with a B.S. in chemical engineering, Mr. Smith obtained an M.S. in the same field a year later and then joined Socony-Vacuum.

Mr. Smith

Mr. Leva

While with the petroleum company, he was in refinery technical service work on a variety of problems including an investigation of the liquid phase drying characteristics of petroleum products. Since becoming associated with Kemp, he has been engaged in design, estimation and sales activities on adsorptive type dehydration equipment, protective atmosphere generators, and the like.

Max Leva, consulting chemical engineer, has written many articles and technical papers in the fields of fluidization, heat transfer, catalysis, and related topics. Born in Germany in 1913, he has an M.S. in chemical engineering from Carnegie Institute of Technology, and was associated with the Bureau of Mines' Synthetic Liquid Fuels program from 1944 to 1949.

Since that time, Mr. Leva has been engaged in consulting work for the process industries and equipment manufacturers. He maintains offices, laboratory, and pilot plant facilities in Pittsburgh. He is a member of American Institute of Chemical Engineers, American Chemical Society, and is a registered professional engineer.

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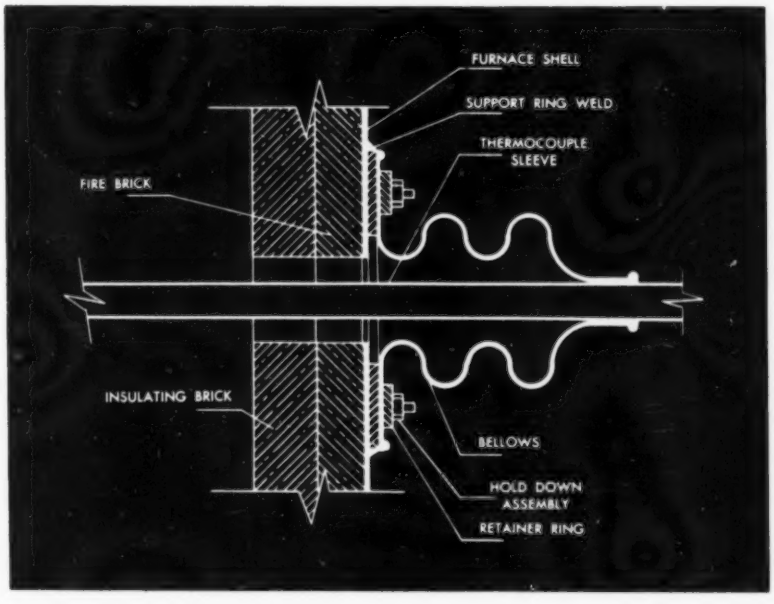


Bellows Seals Furnace Couples

By W. H. DECKER
Sinclair Refining Co.*

USING thermocouples to determine the skin and metal temperature in fired furnaces or boilers presents the problem of providing air-tight seals in the furnace casing where the thermocouples have been installed.

If this air leakage is not prevented, there is a loss in draft capacity and a lowering of overall furnace efficiency. This is particularly true in process heating furnaces, wherein a large number of such couples are used. With present-day high fuel costs and crowded furnace conditions, it is important to obtain maximum equipment capacity.

A simple solution to this problem, which will serve as an air-tight seal and at the same time provide for differential expansion between the tubes and the furnace casing, is shown in the accompanying drawing.

The seal proper consists of a synthetic rubber bellows, preferably of the silicone base type, which is slipped over the thermocouple protecting sleeve and then fastened to the furnace shell. The bellows should be fabricated with a neck which fits on the protecting sleeve and a four-bolt flange arrangement for attachment to the furnace shell. To install the bellows, a small ring with integral bolts is welded to the furnace casing and the bellows put in place. A companion metal retainer ring is slipped over the bellows flange and bolted into place. This provides the air-tight seal, although a sealing medium may also be used if desired.

The silicone rubber in the bellows will resist the effects of high temperature radiation from the furnace chamber, and the conducted heat from the couple-protecting sleeve. By standardizing upon a size for the thermocouple and the opening through the furnace casing, it is possible to make use of a common size bellows for all installations.

* Mr. Decker, a previous contributor to these pages, is associated with Sinclair at the East Chicago, Ind. Refinery.

How to Reduce Maintenance Costs

ONE very satisfactory way to reduce maintenance costs is by special study of specific problems. This procedure has been used successfully by one company where the studies were conducted by means of a committee organization.*

The trouble with most accounting systems, this company found, is that they don't tell management or the maintenance department how much they *should* be spending. Conventional systems usually report only how much *is being* spent and *where* it is being spent.

The committee program resulted a couple of years ago when the vice-president of manufacturing requested each plant manager to come to headquarters for a staff conference, prepared to discuss the problem of maintenance costs and their control. First, a main committee consisting of an assistant works manager from each of the larger manufacturing locations, was appointed as a master steering committee. Then, each of these assistant works managers established local committees in his own plant to investigate and report on the subjects they chose.

The local steering committees established a number of general objectives, and established sub-committees to make intensive study on each specific general objective. The sub-committees consisted of personnel from maintenance, engineering, and production.

Typical of the kind of information obtained from these detailed investigations by the sub-committees:

1—Information about classes of machines on which maintenance costs are relatively high, and about individual machines in the same class which require abnormal maintenance attention.

2—Data on the frequency of specific repairs, adjustments, and checks.

3—Average labor and material costs for repetitive maintenance operations.

4—Points of frequent and serious failure, which can be scrutinized for design or engineering improvement or for preventive maintenance.

5—Points at which work simplification and improved methods might be employed to an advantage.

6—Data on the effectiveness with which maintenance personnel is being utilized, and the amount of waiting or stand-by time, particularly in the case of residence maintenance personnel assigned to shop areas.

What were some of the results this kind of investigation produced? For one thing, it uncovered items that should have been obvious but nevertheless escaped the attention of responsible personnel for some months.

For example, electric motors were being repaired at a cost of $80.00 each, whereas new motors could have been purchased for $50.00.

Highly refined hydraulic oils, costing 60c/gallon, were being used for ordinary lubrication purposes, where a 33c oil was adequate. Also, several

identical oils and greases were being stocked under different brand names.

Welding fixtures could be redesigned to reduce maintenance efforts from the equivalent of 1½ men to that of about ½ man per week.

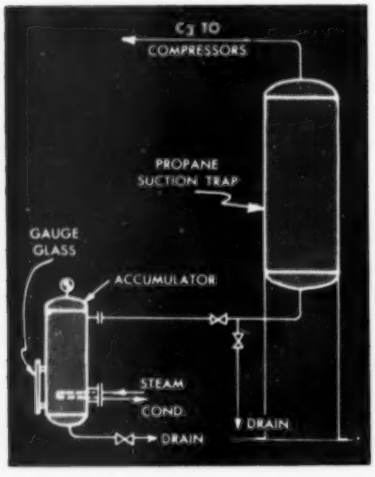
One piece of equipment required a bearing change every week. Through a change in the type of lubricant, bearing life was extended to 25 weeks and longer.

A comparison approach was not found practical. The merits of relating maintenance expense to various common denominators, such as power consumed in kilowatt-hours, machinery investment in dollars, and so on, was studied in a vain effort to develop a uniform measuring stick. These figures report only what maintenance *has* cost, and do not reflect what maintenance *should* cost. Also, they fail to reflect differences in operations in various shops; for example, maintenance and repair work on tiny items versus large, bulky, and complicated items.

In general, the company concluded that the best way to obtain optimum maintenance is to analyze the details of each job, just as they analyze the details of any production job which was in trouble from a quality schedule or cost angle.

* "Reducing Maintenance Costs by Special Studies," by M. H. Howarth, Superintendent, manual apparatus shops, Kearny Works, Western Electric Co., Kearny, N. J., presented at the Third Plant Maintenance Conference and Show, Philadelphia, Penna.

Stop Foaming in Propane System



By WILLIAM C. LONG
Socony-Vacuum Oil Co., Inc.,
Paulsboro, N. J.

IN the refrigeration section of the solvent dewaxing unit at the Paulsboro, N. J. refinery of Socony-Vacuum Oil Co., Inc., a level of what was assumed to be liquid propane accumulated in the suction trap ahead of the high-speed, centrifugal propane compressors.

This material was very difficult to remove from the suction trap by way of the normal pumping-out system. At times, it increased in volume until the sensitive, high-level trip-out device was reached, resulting in an unwanted shut-down of the compressor.

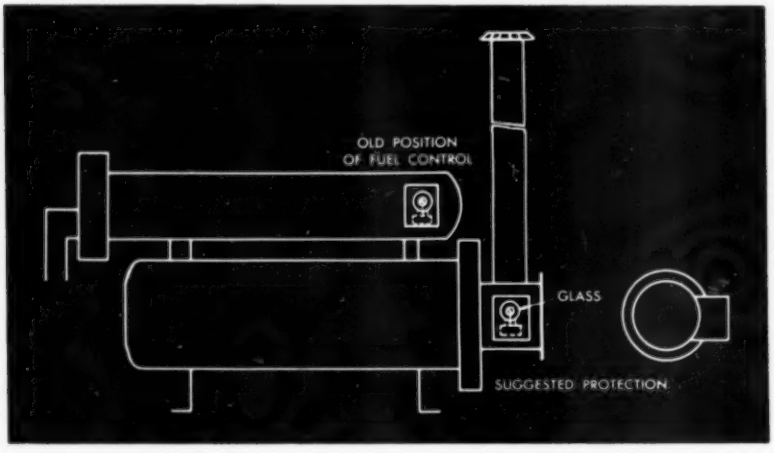
An investigation showed the accumulated material to be a mixture of propane and a small quantity of lubricating oil, which leaks internally through the compressor into the gaseous propane stream and is carried along with the chilled propane into the suction trap. There, under the lower pressure existing in the suction trap, some of the propane tends to vaporize and leave the oil, resulting in a refrigerating effect upon the residue. This in turn retards the vaporization of the propane and the end result is a mass of foam.

The foam apparently has a density of sufficient magnitude to actuate the high-level trip-out device. Yet, whenever an attempt was made to remove the foam from the suction trap through the normal pumping system, the propane apparently vaporized in the pump, resulting in vapor-lock and loss of pump action.

This condition was relieved by installing a small insulated receiver of about one bbl. capacity, adjacent to the suction trap and connected to it through a 3-in. pipe, as shown in the accompanying sketch. The receiver contains a small steam coil in the bottom.

The foam is of such a consistency that it runs by gravity into this receiver through the 3-in. pipe. The small heating coil—of about two sq. ft. of surface and supplied with 35 psi. steam—vaporizes the propane. Propane flows upward through the same 3-in. pipe, countercurrently to the incoming foam, which it partially preheats, and on into the suction trap.

Propane-free oil is then drawn from the bottom of the receiver. No further trouble has been experienced with the trip-out device since the installation of this system.

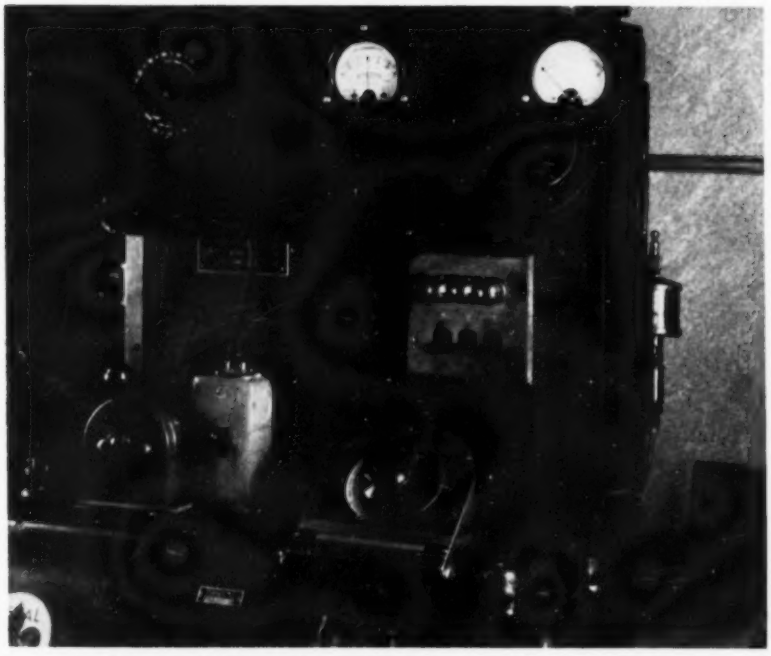


Protected Heater Fuel Control

IN an original installation the fuel control pilot had been mounted on the side of the top drum of an insulated steam heater, which operated at 275 psi. Unfortunately, during freezing weather the condensed steam in the bourdon tube of the pilot and the pressure gage would freeze. This damaged the controls, causing the burner to go out or fail to shut off and blow the soft plug.

As a solution, the pilot control and pressure gage were moved to a location on the heater stack breeching. A metal box, with removable cover, was attached to the breeching to enclose the controls. The rim and glass from a 6-in. .pressure gage was installed in the front cover of the box for observing the steam pressure gage without removing the cover. During hot weather the cover is left off the box. Since the time the installation was made, three winters ago, no further trouble has occurred.

The preceding article is based on a prize-winning "Plant Kink" By Zack C. Bennett, Continental Oil Co. Basile, La., and presented at the Tyler, Texas, meeting, October 24, 1952, of the Natural Gasoline Association of America.



INDICATORS AND CONTROLS as mounted at end of lathe

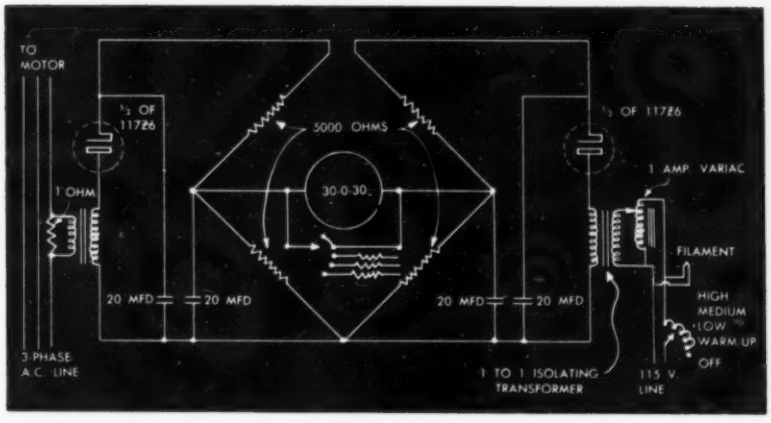


FIG. 1—Circuit diagram of the tool failure detector

Tool Failure Indicator Aids Research on Cutting Oils

A tool failure indicator, particularly adaptable to research on cutting oils, is being used for that purpose at the Pure Oil Research and Development Laboratories at Crystal Lake, Ill.

Developed by Robert Proctor and Lynn E. Ellison, engineers at Crystal Lake, and patented by the Pure Oil Co.,* the instrument provides immediate indication of incipient tool failure of, say, a metal cutting lathe tool bit before such failure has gone so far as to ruin the surface being cut or to damage the tool itself so that it requires complete regrinding to again be usable.

In essence, it measures accurately changes in power used by the lathe drive motor by means of an electronic circuit sensitive to very small changes in power.

The instrument consists of one electronic tube, a sensitive indicating meter and associated resistors, condensers, transformers, and switches, as illustrated in Fig. 1. The circuit forms a typical bridge network. Its principle of operation is as follows, as developed for indicating load changes on the 3-phase A.C. motor driving an engine lathe (see photograph).

In one leg of the power supply to the 3-phase drive motor, a resistor of low resistance but high wattage is inserted. Across this resistor is connected the primary of a high ratio, step-up transformer. The value of the resistor is such as to provide a voltage drop at normal load equal to the voltage requirement of the transformer primary. Any small change in current drawn through the resistor, such as would be occasioned by an increase in load due to tool failure, causes the voltage drop across the resistor to change proportionately.

The voltage applied to the transformer primary thus changes accordingly and this change is amplified in the secondary by the turns ratio of the transformer. The output of the transformer is rectified in one-half of a full wave rectifier tube, such as the 117Z6 shown in Fig. 1.

Current path, considering conventional current flow, is from one side of the transformer secondary to the plate, from plate to cathode, thence through two resistors in series and back to the other side of the transformer secondary.

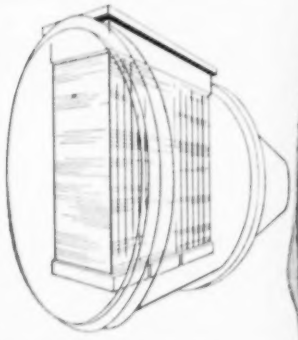
The right half of the bridge is identical to the left; from the transformer secondary through the other half of the rectifier tube and resistor network, the only difference being in the source of supply. This half is supplied through a variable voltage autoformer and an isolation transformer. The voltage thus set up in the circuit is constant at any setting of the autoformer and serves as a reference voltage.

Then, the instrument compares the current in one-half of the bridge circuit with that in the other half by means of a meter connected across the bridge as shown.

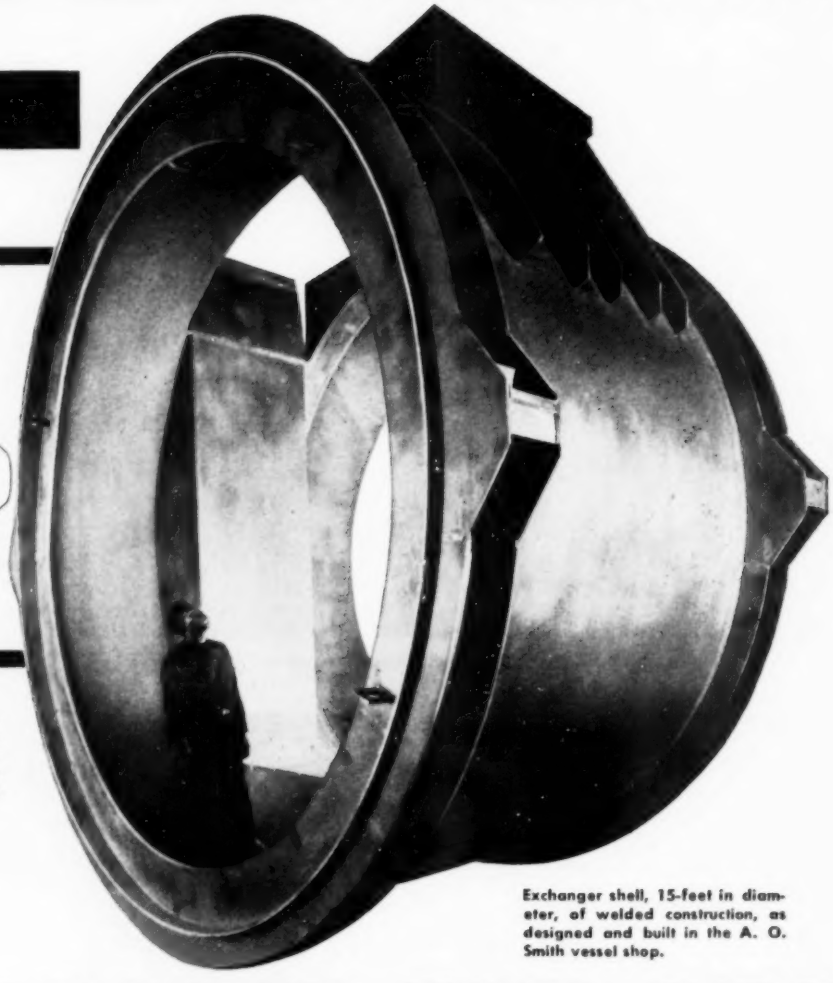
A 30-0-30 microampere meter (D.C.) is connected across the center taps of the two sets of series resistors, and the meter itself is shunted by a switch and number of resistors. The sensitivity of the instrument depends upon the value of the shunt resistance selected. Any change in current in either half of the bridge then causes a difference of potential to appear across the meter, and it

A.O.Smith for

VESSELS



Sketch shows general arrangement of assembled exchanger. Tube bundle is installed through rectangular opening in the top on which tube sheet rests.



Exchanger shell, 15-feet in diameter, of welded construction, as designed and built in the A. O. Smith vessel shop.

COOLER FOR GAS

A case history of A. O. Smith design, engineering and manufacturing skill

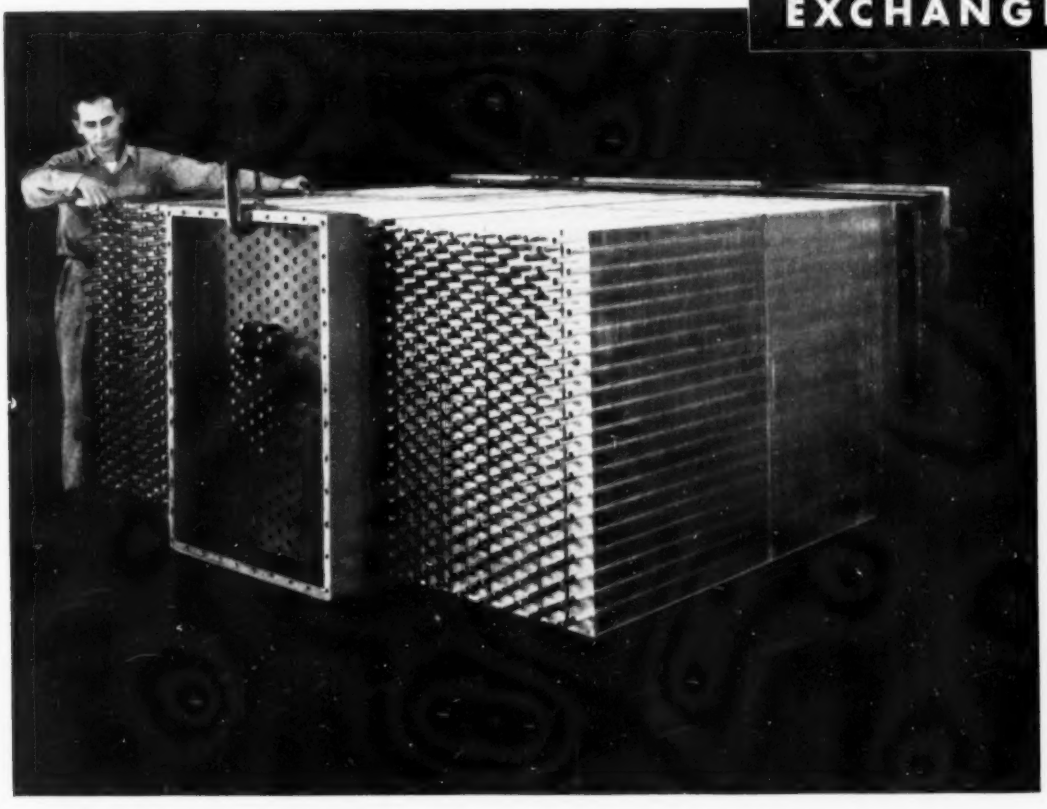
It required the combined pressure vessel and heat exchanger shops of A. O. Smith to produce this, and similar coolers, for the Gas Dynamics Facility of the Arnold Engineering Development Center at Tullahoma, Tennessee. They will cool air for a supersonic wind tunnel. Thermal capacity of this cooler is approximately 85,000,000 BTU/hr. It is designed for 140 psi on the water side, full vacuum on the air side, and to handle as much as 1,890,000 pounds of air per hour with inlet temperatures as high as 410° to 435° F.

The shell, above, is so big and tolerances so exacting that its construction required the services of a manufacturer with a proved record of diverse vesssel experience to fabricate it. It is a weldment, 15 feet in diameter. Yet, maximum out-of-round tolerance is but ¼ of wall thickness and the ends of the vessel are perpendicular to axis within −0° 10′. Clearance between baffles and the tube bundle, when installed, is held to 0.125 inch to prevent air by-pass.

Few manufacturers can take on the responsibility for such a vessel and at the same time provide the equally exacting tube bundle which it houses.

Outstanding Advantages

EXCHANGERS



Tube bundle for exchanger as designed and built in the A.O. Smith heat exchanger shop.

DYNAMICS FACILITY

The tube bundle, providing approximately 80,000 square feet of outside surface, is made up of ¾-inch tubes and aluminum fins spaced 12 to the inch, mechanically bonded to the tubes. Multiple floating heads, of A. O. Smith design, assure freedom from thermal stress, meet the extreme operating conditions in service and permit ready accessibility for replacement of a portion of the bundle or individual tubes.

This outstanding example of vessel and exchanger fabrication in one shop reveals the capacity of A. O. Smith Corporation to satisfy your most exacting pressure vessel and heat exchanger problems. Opportunities are invited to assist in planning, designing and fabricating complete vessels and thermal transfer units. Inquiries will receive prompt and expert attention.

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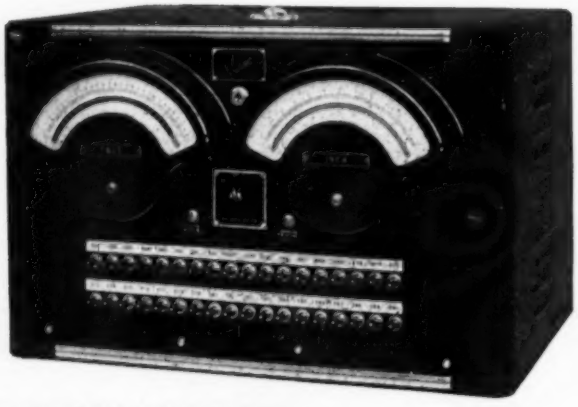
FIGURE NO. 9200-R KEY SWITCH TYPE



"Varec" REMOTE READING TANK GAUGE RECEIVERS

This newly designed "VAREC" Tank Gauge Receiver is equipped with 36 key-type switches instead of the usual dial selector. Tank selection is positive and more rapid. Human error is reduced to a minimum because each switch is associated with its individual tank. The Receiver design is flexible permitting easy custom panel installations when desired. Tank numbers may be changed to suit user's convenience. This latest addition to the "VAREC" line of Electronic Gauger Systems is fully described and illustrated in Bulletin No. CP-3003.

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will indicate the direction and the amount of the change.

In operation, the shunt switch is set so that the meter is short-circuited. The lathe motor is started and the tool cut is started. The selector switch is then set to the first shunt, a very low value, and the variable autoformer is adjusted until the current in both sides of the bridge circuit is the same, as indicated by a center zero reading on the meter.

The next higher resistance shunt is then selected, a final adjustment is made on the autoformer, and the highest resistance shunt then selected. The value of this shunt is predetermined such that the meter does not fluctuate rapidly with the minute transient power changes caused by gear irregularities, vibration, etc., but rather indicates a change of several scale divisions with the slightest permanent increase or decrease in load.

If the 115-volt supply is of the same polarity and from the same source as the leg of the lathe motor supply line containing the sensing resistor, line voltage fluctuations will have little effect on the reading because the variations will cancel out in the bridge network. The condensers across the bridge resistors act to filter the rectified A.C. and to provide a D.C. at the meter terminals which is fairly free of ripple.

The instrument can be adapted to any equipment which is driven by an electric motor and it will indicate extremely small changes in the load on that motor. Similarly, a recording instrument, an alarm system, or other refinements could be added in the meter circuit to provide any type of result desired. An automatic control system can also be developed around this fundamental unit by the addition of an amplifier.

Earlier devices of this type had already been developed, but the Pure Oil engineers found each had some disadvantages. For example, recording wattmeters have been used but are not sensitive enough to detect the minute load changes. Tool dynamometers, tool-tip temperature measuring devices, and electrical resistance methods have been tried and found lacking. Several types can detect the failure after it has progressed too far to save the metal surface or the tool.

The new Pure Oil device will detect smaller changes than any other methods tried at Crystal Lake and has been found to indicate virtually instantly the moment the cutting tool starts to fail. A minimum of grinding will restore the tool bit to usefulness, and the change in the work surface is not detectable to the naked eye.

• U. S. Patent 2,605,304.

Photochemical Reactions Useful in The Conversion of Hydrocarbons

THE use of radiant energy for the conversion of less useful into more useful hydrocarbons is outlined in U. S. Patents 2,636,853-4 issued to Standard Oil Development Co. For example, the alkylation of a paraffin with an olefin is effected in the presence of an energized metallic sensitizer under conditions such that the sum of the energy of resonance frequency absorbed by the metal sensitizer and of the energy of the metal-hydrogen bond correspond to an energy content in excess of that required to rupture one of the paraffin carbon to hydrogen bonds.

The most suitable metal sensitizers and the frequencies at which they may be activated are given in the following table:

Element	Resonance Lines, A.
Hg	2,537 1,850
Cd	3,261 2,289
Zn	3,076 2,139

In one example, a 1:1 molar mixture of isobutane and propylene were reacted in presence of mercury vapor. This was accomplished by running a 15W mercury vapor lamp emanating light of 2537A, and inserted in a Pyrex jacket cooled by water on the outside. A few globules of mercury were placed in the jacket kept at 175° F. and 760 mm. pressure, and the reactants were passed through at a rate giving a residence time of 4 minutes. Upon analysis, the products were analyzed and contained 19% 2, 2, 3-trimethyl butane, 33% 2,2,3,3-tetramethyl butane, 30% olefins and 18% of other hydrocarbons. Although "good yields of high quality products" are claimed, no data are given as to yields per pass.

In the second patent, normal heptane vapor at 250° F. and 760 mm. pressure yielded a product consisting of 88% n-heptane, 0.1% olefins, 8.9% naphthenes, and 3% paraffins other than n-heptane. "Good yields" are claimed here also but no per-pass data are given.

A third patent (2,640,023) discloses the reaction between paraffin hydrocarbons under such conditions. It is apparent from Table I that the C-H bond strength varies with the molecular weight of the hydrocarbon. Also, it is observed that the energy of the primary bond is the greatest, and that of the tertiary bond is the weakest.

It is postulated that, under the effect of irradiation in presence of metallic sensitizers, paraffin hydrocarbon may be made to react by the free-radical mechanism. In one example, a mixture of propane and isobutane (9.85:1) reacted for 4 minutes at 275° F., produced a liquid effluent containing 27.5% 2,2,3-trimethylbutane, 35.0% 2,3-dimethyl butane, 6.5% 2,2,3,3-tetramethyl butane, and 21.0% of other liquids. The gas contained 3.3% hydrogen, 2.1% ethane, 88.0% propane and 5.8% isobutane. A formula is worked out for most desired mol ratio of reactants.

Indium Laurate Proposed As a Motor Fuel Additive

THE addition of 0.12 gm. of indium laurate per gallon of gasoline was reported to give an average exhaust temperature about 40° F. lower than when no additive was used. Also, the throttle did not have to be opened so far by the governor to maintain the constant speed. The oil temperature in the engine running on laurate was 4° F. lower, and the increase in time of the run showed that about 7.7% more available energy was released in the case of the indium laurate-containing fuel (Indium Corp. of America Patent 2,628,895).

The Extraction of Sulfur Compounds from Naphthas

AN ideal way for removing sulfur compounds from gasolines and other naphthas is by means of a selective solvent. Unfortunately no solvent has yet been found which will not also extract enough hydrocarbons (mainly aromatics) to make such a process of questionable commercial value. For example, in U. S. Patent 2,360,861 covering the use of substituted sulfolanes as extractants, the sulfur compounds are accompanied in the extract by appreciable amounts of hydrocarbons, and a problem is presented in economical disposal of the extract so produced. It is usually hydroformed or hydrodesulfurized.

In U. S. Patent 2,634,230, Standard Oil Co. (Indiana) describes an extraction method using 2,4-dimethylsulfolane solvent which is specifically adapted for high sulfur olefinic naphthas, those containing 0.5-1% sulfur or more, and olefin-to-paraffin ratios of 3:1 to 1:3, particularly stocks in which the olefinic content exceeds the paraffinic content. Such a stock is coke still naphtha having an olefin-to-paraffin ratio of 2:1 and containing 0.25 to 4% sulfur by weight.

The extractant is 2,4-dimethylsulfolane (b. pt. 281° C.), preferably containing about 2% water which reduces somewhat the desulfurization efficiency, but increases considerably the desulfurization selectivity (percent desulfurization divided by the treating loss). A surprising result is that the extraction of high sulfur olefinic naphtha does not produce any appreciable change in the paraffin-to-olefin ratio.

An extraction at room temperature gave a raffinate recovery of 70% with a desulfurization of 72% and a desulfurization selectivity of 2.4. An important feature of extracting high sulfur olefinic naphtha with dimethylsulfolane is that there is no condensation, polymerization or alkylation normally encountered with HF and similar solvents.

This patent proposes the hydrodesulfurization of the extract.

Table 1—Effect of Molecular Weight on Bond Strength

Compound	C-H Bond	N(1)	Bond Energy in Kilocalories
Methane	Primary	4	102
Ethane	Primary	6	97.2
Propane	Secondary	2	90.8
n-Butane	Secondary	4	88
iso-Butane	Tertiary	1	86.5
n-Pentane	Secondary	6	88.5
iso-Pentane	Tertiary	1	86

(1) N=number of hydrogens of that type (i.e., primary, secondary, tertiary) in molecule.

Patents Issued in June

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for June 2, 9, 16, 23, *and* 30, 1953, *Vol.* 671, *Nos.* 1-5.

PROCESSES

Catalysts

2,642,448 (Standard Oil Development Co.)—Hydrocarbon synthesis.

2,643,527 (Hydrocarbon Research, Inc.)—Precooling air in oxygen production.

2,644,006 (Shell Development Co.)—Separation of oxygenated organic compounds from Fischer-Tropsch reaction.

2,641,044 (Phillips Petroleum Co.)—Process for manufacturing mullite-containing refractories.

2,641,582 (Universal Oil Products Co.)—Regeneration of a platinum-containing catalyst.

2,641,583 (Sinclair Refining Co.)—Process for producing silica gel spheres in oil.

2,642,337 (Aluminum Co. of America)—Method of converting crystalline alumina hydrate to alpha alumina.

2,642,401 (California Research Corp.)—Catalyst recovery ($Mo-Al_2O_3$).

2,643,215 (Houdry Process Corp.)—Treatment

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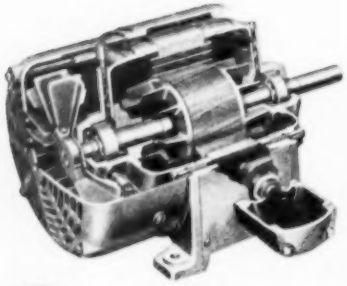

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and use of porous contact masses, employing stratification.
2,643,231 (Sinclair Refining Co.)—Preparation of hydrogel beads for drying by treating with surface active agent.
2,643,939 (Anglo-Iranian Oil Co. Ltd.)—Process for recovery of sulfur from sulfur-contaminated metallic catalysts, reacting sulfur dioxide with hydrogen sulfide.
2,643,990 (Eugene J. Houdry)—Preparation of a multilayer catalyst.

Conversions

2,641,335 (Union Oil Co. of California)—Gas-solid separator.
2,641,450 (Hydrocarbon Research, Inc.)—Method of transferring heat by a powdered thermophore in a state of dense phase fluidization.
2,641,565 (The Texas Co.)—Treatment of shale with microorganisms.
2,641,566 (Texaco Development Corp.)—Recovery of hydrocarbons from shales etc. by treating with hydrogen in presence of hydrogenase-producing organisms.
2,641,573 (Standard Oil Development Co.)—Production of motor fuels from petroleum oils, using fluidized cracking, etc.
2,642,381 (The M. W. Kellogg Co.)—Heat transfer between exothermic and endothermic reactions.
2,642,383 (Universal Oil Products Co.)—Catalytic reforming of hydrocarbons with platinum catalyst.
2,642,384-5 (Universal Oil Products Co.)—Process for reforming of hydrocarbons boiling within the gasoline range utilizing a platinum-alumina-halide catalyst.
2,642,402 (Standard Oil Development Co.)—Olefin polymerization catalyst, (phosphoric acid on silica gel.)
2,642,463 (E. I. du Pont de Nemours & Co.)—Metal tungstite catalyzed hydrogenation process.
2,642,466 (Shell Development Co.)—Production of olefinic hydrocarbons by thermal cracking of waxy hydrocarbons.
2,643,183 (Standard Oil Development Co.)—Reactor having nonplugging valve nozzle.
2,643,214 (Universal Oil Products Co.)—Method of reforming hydrocarbons in the presence of a platinum or palladium catalyst.
2,643,216 (Phillips Petroleum Co.)—Semi-continuous device and process for converting hydrocarbons, using pebbles.
2,643,218 (Standard Oil Development Co.)—Fluid-type shale retorting.
2,643,219 (Standard Oil Development Co.)—Fluidized distillation of oil-shale.
2,643,971 (Standard Oil Co.)—Combination HF treating catalytic cracking process.

Hydrocarbon Synthesis

2,640,843 (The M. W. Kellogg Co.)—Synthesis of organic compounds.
2,640,844 (The M. W. Kellogg Co.)—High velocity process for synthesis of organic compounds.
2,640,845 (The Texas Co.)—Hydrocarbon synthesis.
2,642,340 (Standard Oil Development Co.)—Production of oxygen from air by use of solid acceptor.
2,642,346 (Hydrocarbon Research, Inc.)—Process and apparatus for exothermic reactions (hydrocarbon synthesis).

Refining

2,640,802 (Anglo-Iranian Oil Co. Ltd.)—Hydrocatalytic desulfurization of naphthene-containing petroluem hydrocarbons.
2,641,526-7 (Sun Oil Co.)—Removing H_2S from gas with ferrous hydroxide suspension.
2,641,564 (Texaco Development Corp.)—Process of removing sulfur from petroleum hydrocarbons and apparatus by contacting with hydrogen in presence of enzymatic catalysts.
2,641,569 (Shell Development Co.)—Wax refining process, using sweeting.
2,641,570 (Standard Oil Development Co.)—Sweetening petroleum oils with NaOH, alkali rosinate and petroleum phenols.
2,641,571 (Sun Oil Co.) — Removal of H_2S from mineral oil distillates using iron salt slurry.
2,641,572 (The Texas Co.)—Dethiolizing hydrocarbons with caustic and glycol ether.
2,641,574 (The Standard Oil Co.)—Process and apparatus for decolorizing oil with pulverule contact agent.
2,642,153 (Eastman Kodak Co.)—Gas separation by adsorption and preferential desorption.
2,642,154 (Imperial Chemical Industries, Ltd.)—Treatment of gaseous mixtures by contacting with liquid absorbent.
2,642,341 (Standard Oil Development Co.)—Liquid-liquid extraction tower.
2,642,377-8 (Shell Development Co.)—Dewaxing lubricating oils with urea (and cresol).
2,642,379 (Socony-Vacuum Oil Co., Inc.)—Separation of wax and asphalt from hydrocarbon oil, using urea and cresol.
2,642,380 (United States of America)—Recovery of waxes from shale oil.
2,642,382 (Houdry Process Corp.)—Refining hydrocarbon oils with aqueous ferric chloride, etc.
2,642,386 (Sinclair Research Laboratories, Inc.)—Laboratory flash still for heavy oils.
2,642,421-2 (Socony-Vacuum Oil Co., Inc)—Separation of hydrocarbons and hydrocarbon derivatives using urea and thiourea.
2,642,423 (Socony-Vacuum Oil Co., Inc.)—Urea-olefin complexes.
2,642,424 (Socony-Vacuum Oil Co., Inc.)—Method of separating hydrocarbons with thiourea.
2,642,955 (Aluminum Co. of America)—Gas separation by adsorption.
2,642,956 (National Cylinder Gas Co.)—Method of removing acetylene from gaseous mixtures by scrubbing with ester of phosphoric acid.
2,643,217 (Standard Oil Development Co.)—Production of high viscosity index lubricating oils by silica gel treatment of oil.
2,643,228 (The Pure Oil Co.)—Gel modifier for crude oils by introducing condensation product of fatty acid salt of aluminum and an alkylol amine.
2,643,525 (Independent Engineering Co., Inc)—Absorber for removing hydrocarbons from gases.
2,643,541 (Phillips Petroleum Co.)—Means and method for measuring and controlling hydrate forming conditions by pressure reduction.
2,643,938 (Phillips Petroleum Co.)—Purification of spent sulfuric acid by heating with oxidizing agent liberating nascent oxygen.
2,643,972 (Phillips Petroleum Co.)—Continuous adsorption-desorption process.
2,644,018 (Sun Oil Co.)—Continuous adsorption process.

PRODUCTS

Chemicals

2,640,757 (Phillips Petroleum Co.)—Production of ammonium sulfate and calcium carbonate.
2,640,758 (Robert S. Aries and Arthur Poll)—Method of oxidizing sodium sulfide to sodium sulfite in successive oxidation stages.
2,640,804 (Phillips Petroleum Co.)—Separation of substituted aromatic compounds.
2,640,815 (Shell Development Co.)—Resinous products from dihydropyran derivatives and method for producing the same.
2,640,821 (Phillips Petroleum Co.)—Polymerization process for butadiene-styrene.
2,640,822 (Shell Development Co.)—Acylated complex oxygen-containing polyamines.
2,640,846 (Rohm & Haas Co.)—Process for preparing organic isocyanates.
2,640,848 (Shell Development Co.)—Esters of sulfur-containing polycarboxylic acids.
2,640,857 (Shell Development Co.)—Chlorinated polymers of branched chain 1, 3-hexadienes.
2,641,590 (E. I. du Pont de Nemours & Co.)—Carbon monoxide copolymers and a catalytic process for their preparation.
2,641,595 (Standard Oil Development Co.)—Production of clear transparent polymers (isobutylene-styrene).
2,641,600 (Standard Oil Co.—Indiana)—Alkenylation of furans.
2,641,613 (Standard Oil Development Co.)—Catalytic synthesis of alcohols by continuous carbonylation.
2,641,619 (The Dow Chemical Co.)—Production of diolefins from olefins by catalytic dehydrogenation.
2,641,620 (Standard Oil Development Co.)—Process for the finishing of polyisobutylene.
2,641,710 (Shell Development Co.)—Radiological gas analysis.
2,642,388 (Stanolind Oil and Gas Co.)—Distillation of amyl alcohols from ketone-containing mixtures.
2,642,389 (Standard Oil Development Co.)—Treating method for high-boiling esters.
2,642,407 (Socony-Vacuum Oil Co., Inc.)—Esterified aromatic hydracarbon plasticizers and compositions containing same.
2,642,453 (Standard Oil Development Co.)—Preparation of borates of tertiary alcohols.
2,642,454 (Phillips Petroleum Co.)—Process for making nitriles.
2,642,455 (Socony-Vacuum Oil Co., Inc.)—2-Ethyle-hexanol-1 esters of the Friedel-Crafts maleic anhydride-aromatic hydrocarbon adducts and process.
2,642,461 (Shell Development Co.)—Organodiphosphine oxides and sulfides.
2,642,464 (Shell Development Co.)—Production of methallyl halides.
2,642,536 (Standard Oil Development Co.)—Multicomponent gas analyzer.
2,643,239 (Shell Development Co.)—Nitrogen-containing polyethers and process for cur-

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ing glycidyl polyethers to resinous products.
2,643,241 (Phillips Petroleum Co.)—Stabilization of poly-sulfone resins with organic sulfides.
2,643,243 (Shell Development Co.)—Curing glycidyl polyethers of dihydric phenols with sulfonic acids.
2,643,248 (The Pure Oil Co.)—Method of sulfurizing terpene hydrocarbons.
2,643,263 (California Research Corp.)—Higher secondary-alkyl orthosilicates.
2,643,266 (Sinclair Refining Co.)—Production of nitrogen containing compounds from ammonia and olefins.
2,643,269 (Socony-Vacuum Oil Co., Inc.)—Halogen-promoted oxidation.
2,643,272 (Shell Development Co.)—Halo-substitution of organic compounds.
2,643,993 (Standard Oil Development Co.)—Continuous process for copolymerizing styrene and isobutylene.
2,644,016 (Ethyl Corp.)—Chlorination of ethane.
2,644,017 (Standard Oil Co.—Indiana) Disproportionation of diethylbenzene.

Fuels

2,641,538-9 (Universal Oil Products Co.)—Preventing discoloration of fuel oils with benzalaminoalkanol or furfuralaminoalkanol.
2,642,344-5 (E. I. du Pont de Nemours and Co.)—Alkali metal dispersions in hydrocarbon with ROX compound as diesel fuel.
2,642,467 (Phillips Petroleum Co.)—Production of high octane fuel components (polymers).
2,643,184 (United State of America)—Propellent charge for jet-propelled devices, comprising chlorinated rubber, etc.
2,643,942 (California Research Corp.)—Light stable fuel composition containing N, N'-dimethyl phenylene diamine to prevent knocking.

Lubricants

2,640,811 (Standard Oil Co., Indiana)—Demulsifiable E.P. lubricant compositions.
2,640,812 (Swan-Finch Oil Corp.)—Grease containing modified montmorillonite.
2,641,578 (Standard Oil Development Co.)—Compounded lubricating oil containing amine salt of pentochlorophenol.
2,642,395 (Dow Corning Corp.)—Siloxane boundary lubricants.
2,642,396 (The Texas Co.)—Hydrocarbon oil containing a mercaptobenzimidazole as corrosion inhibitor.
2,642,397 (Standard Oil Development Co.)—Lubricating grease compositions containing aromatic phenolic amide.
2,642,452 (Standard Oil Development Co.)—Phosphoric ester base synthetic lubricating oil.
Reissue-23,671 (Standard Oil Development Co.)—Extreme pressure lubricant.
2,642,722 (Tide Water Associated Oil Co.)—Lubrication of steam Cylinders with oil containing alkyl acid phosphate.
2,643,261 (Standard Oil Development Co.)—Phosphorus-containing lubricating oil additives.
2,643,262 (E. I. du Pont de Nemours and Co.)—Organic-solvent soluble compounds of titanium.
Reissue-23,676 (The Standard Oil Co.)—Method of processing solvent-extracted lubricating oil by treating with phosphorus pentasulfide, and a base and the resulting products.
Reissue-23,677 (The Standard Oil Co.)—Method of processing lubricating oil by treating with sulfuric acid a phosphorus sulfide, and a base and the resulting products.
2,643,979 (Standard Oil Co.)—Demulsifiable lubricant compositions, containing asphalt and quaternary compound.

Specialties

2,640,782 (Universal Oil Products Co.)—Printing ink containing a polymerized olefin.
2,640,803 (Shell Development Co.)—Process of treating asphalt with fluorinated phosphoric acid.
2,640,809 (Sinclair Oil and Gas Co.)—Prevention of corrosion of oil wells with high molecular weight wax acids.
2,641,533 (Phillips Petroleum Co.)—Treatment of carbon black with oxyhalides.
2,641,534 (Phillips Petroleum Co.)—Carbon black furnace and process for making carbon black.
2,641,535 (Phillips Petroleum Co.)—Treatment of furnace blacks.
2,641,551 (Gulf Oil Corp.)—Metal coating compositions (asphalt-wax).
2,642,343 (Phillips Petroleum Co.)—Pelleting of carbon black.
2,642,366 (Marathon Corp.)—Method of coating cellulosic sheet material with molten hydrocarbon wax.
2,643,176-7 (Shell Development Co.)—Vapor phase corrosion inhibition of metals with organic nitrogen base nitrite salt.
2,643,178 (Shell Development Co.)—Corrosion inhibition with ammonium nitrite salt.
2,643,200 (Standard Oil Development Co.)—Clay polymer treatment for fiberboards.
2,643,227 (Cities Service Oil Co.)—Method of inhibiting corrosion of metals, using reaction product of polyethylene amine and aldehyde.
2,643,962 (A. Johnson & Co.)— Preventing sludge formation in transformer oil by adding metal dithiophosphate.
2,643,973 (Sun Oil Co.)—Nonsticking wax article and method of preparation, by coating with oil of 40-7000 S.U. at 100° F.
2,643,977-8 (Cities Service Research and Development Co.)—Method of inhibiting corrosion of metals with diethylene-triamine-aldehyde condensation product.

EQUIPMENT

Processing, General

2,640,332 (Arthur D. Little, Inc.)—Equipment for producing high pressure gaseous oxygen.
2,641,335 (Union Oil Co. of California)—Continuous gas-solids separator.
2,641,534 (Phillips Petroleum Co.)—Carbon black furnace and process for making carbon black.
2,641,574 (Standard Oil Co.—Ohio)—Continuous apparatus for decolorizing oil, using a pulverulent contact agent.
2,642,206 (Lummus Co.)—Flow control for granular material.
2,642,341 (Standard Oil Development Co.)—Liquid-liquid extraction tower.
2,642,952 (Trion, Inc.)—Collecting plate assembly for electrostatic precipitator.
2,643,183 (Standard Oil Development Co.)—Reactor having non-plugging valve nozzle.
2,643,216 (Phillips Petroleum Co.)—Hydrocarbon conversion process and apparatus using pebble heat exchange.

Instruments

2,640,269 (Phillips Petroleum Co.)—Liquid level indicator.
2,640,352 (Pure Oil Co.)—Electronic torquemeter and horsepower indicator.
2,640,356 (Bailey Meter Co.)—Variable orifice flow meter.
2,640,358 (Sun Oil Co.)—Constant rate gas sampler.
2,640,768 (Phillips Petroleum Co.)—Automatic on-and-off control system for gas plants.
2,640,769 (Phillips Petroleum Co.)—Gas supply control system.
2,640,870 (Air Reduction Co.)—Apparatus and method for gas analysis using electric arc principle.
2,640,936 (W. S. Pajes)—Fluid flow meter using radioisotopes.
2,640,977 (J. T. Parisi)—Level indicator for solid materials, operated by air pressure.
2,641,710 (Shell Development Co.)—Radiological gas analyzer.
2,641,719 (Phillips Petroleum Co.)—Detonation meter pickup.
2,641,931 (Minneapolis-Honeywell Regulator Co.)—Temperature measuring circuitry of the capacitor-rebalancing type.
2,641,934 (R. A. Werts)—Automatic liquid sampler.
2,642,075 (Martin-Decker Corp.)—Device for relaying a control function through compressed air.
2,642,083 (L. Y. Strong)—Presetting and quick-operating valve regulator control.
2,642,535 (Radio Corp. of America)—Mass spectrometer.
2,642,536 (Standard Oil Development Co.)—Multi-component gas analyzer of infrared type.
2,642,737 (D. Napier & Son Ltd., London, England)—Electrical device for investigating the water content of a gas.
2,647,738 (J. S. Powell, Jr.)—Gas specific gravity meter.
2,642,739 (General Electric Co.)—Torquemeter.
2,643,230 (American Cyanamid Co.)—Universal pH indicator.
2,643,543 (The Texas Co.)—Viscosimeter.
2,643,546 (Schutte & Koerting Co.)—Protective cage structure for tubular gages.

Pumps & Compressors

2,640,428 (Dresser Industries, Inc.) Drive for pump of the rotary, positive displacement type.
2,640,430 (De Laval Steam Turbine Co.)—Screw pump or fluid motor.
2,641,405 (Ingersoll-Rand Co.)—Fluid compressor unit.

Patents

2,642,001 (Bump Pump Co.)—By-pass for a rotary pump.
2,642,003 (Read Standard Corp.)—Blower intake port.
2,642,004 (Dayton Pump & Mfg. Co.)—Centrifugal pump.
2,642,045 (Brown Oil Tools, Inc.)—Fluid motor with piston-actuated pilot valve.
2,642,148 (Gilbert & Barker Mfg. Co.)—Combined pump and air separator unit.
2,642,954 (Ingersoll-Rand Co.)—Air receiver-oil separator.
2,643,614 (General Electric Co.)—Motor-driven dual centrifugal pumping unit.
2,643,615 (R. J. Murphy and E. H. Smith)—Vertical centrifugal pump with central intake, for use in sumps.

Valves & Fittings

2,640,675 (Victor W. Farris)—Manually-operated flexible pinch valve.
2,641,284 (Thornhill-Craver Co.)—High pressure header.
2,642,086 (Buckeye Iron & Brass Works)—Loading valve and method of controlling fluid flow.
2,642,088 (New York Air Brake Co.)—Flow control valve.
2,642,254 (Copes Regulators Ltd., London, England)—Control valve.
2,642,255 (The Weatherhead Co.)—Packless valve.
2,642,256 (T. A. Stehlin)—Valve.
2,642,257 (Mueller Co.)—Rotary plug valve.
2,642,260 (Bell & Gossett Co.)—Flow control valve.
2,643,089 (Mueller Co.)—Unseating structure for rotary plug valve.
2,643,137 (T. L. Smith)—Pipe repair clamp.
Reissue 23,675 (Spence Engrg. Co.)—Pilot-operated valve.
2,643,666 (Vapor Recovery Systems Co.)—Vent valve for storage tanks.
2,643,667 (Reconstruction Finance Corp.)—Reversible application of power to motor-operated valve.
2,643,673 (Babcock & Wilcox Co.)—Pressure relief valve with inlet and outlet in alignment.
2,643,677 (Ohio Injector Co.)—Actuator for a tapered rotary plug valve.

Gaskets & Seals

2,640,736 (Gunnar A. Wahlmark)—Fluid seal for rotating shafts.
2,642,298 (Saywell Associates)—Sealing assembly for shafts.
2,643,141 (Dresser Industries, Inc.)—Shaft seal for pumps, compressors, etc.

Heat Exchangers

2,641,451 (E. W. Kaiser)—Heat exchanger for storage tanks.
2,643,097 (C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne, England) — Regenerative heat exchanger.
2,643,098 (Shell Development Co.)—Heat exchanger and accumulator.
2,643,863 (Hydrocarbon Research, Inc.)—Recuperative heat exchanger and process of manufacturing it.

Laboratory Equipment

2,641,452 (Otto Wagner, Berlin-Schlachtensee, Germany)—Electromagnetic type of mixer.
2,642,258 (Emil Greiner Co.)—Pressure-tight stopcock adapter.
2,642,386 (Sinclair Research Laboratories, Inc.)—Laboratory flash still for heavy oils.
2,642,891 (Tide Water Associated Oil Co.)—Mercury-sealed valve made of glass to shut off fluid flow against a maximum differential pressure.
2,643,940 (U. S. Dept. of the Interior)—Thermally operated extractor for removing soluble constituents in chemical analyses.

Miscellaneous

2,642,944 (Ansul Chemical Co.)—Device for clearing conduits in dry chemical extinguishing systems.
2,643,023 (Chicago Bridge & Iron Co.)—Hose drain for floating roof tanks.
2,643,976 (Worthington Corp.)—Water treatment unit.

How to Obtain Patents

Readers may obtain copies of any U. S. patent from the Patent Office at 25c each. Order by patent number direct from the Commissioner of Patents, Washington 25, D. C.

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(To obtain more data on advertised products see page 1232)

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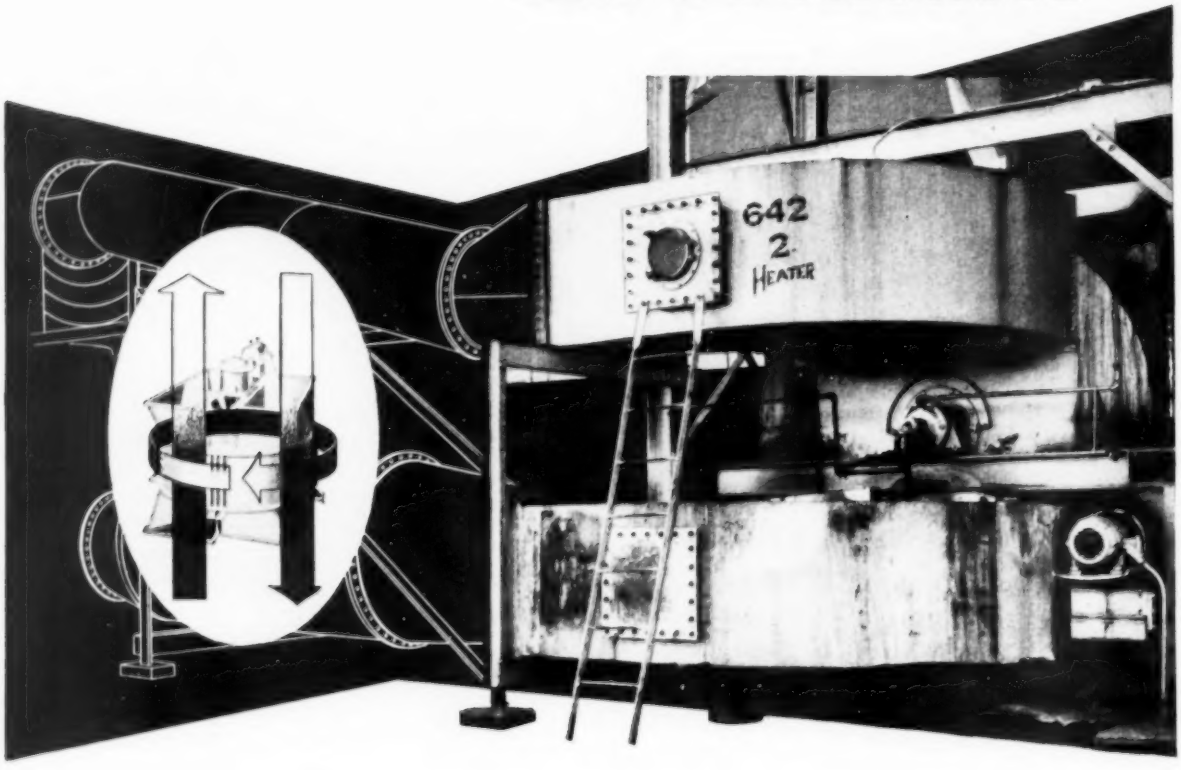

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PERSONALS

NO OFFICERS, NO DUES IN THE ARMADILLO CLUB of which Andrew Jaye (center), of the Standard Oil Co. (Ohio) No. 1 refinery in Cleveland, is the sole member. The Armadillo Club, formed by Sohio this year, is to refinery workers what the Caterpillar Club is to aviators. Membership in the latter is automatic when a pilot saves his life through an emergency parachute jump. A Sohio worker becomes an Armadillo Club member by avoiding serious injury through use of personal protective clothing and equipment. Mr. Jaye was wearing a metal safety hat when a 30 lb. steel bracket fell on him, but the only damage caused was a dented helmet. Presenting his membership certificate is refinery manager J. R. Cuthbert (left), while union safety committee chairman A. J. Steinkamp (right), looks on.

Herman G. Gunter, 23 year veteran in the refinery industry, has been named vice president, refining operations, Suntide Refining Co.

Mr. Gunter

Mr. Gunter, a Johns Hopkins University graduate, began his petroleum career with Standard Oil Co. (N. J.) in 1930 as a laboratory analyst, eventually becoming process superintendent of the Baltimore refinery. He later served in executive capacities with Carter Oil Co. and Continental Oil Co.

Suntide's new refinery at Corpus Christi, Texas, will be Mr. Gunter's headquarters.

* * *

J. W. Colgan is the maintenance supervisor for Monsanto Chemical Co.'s new Avon, Calif., plant. In his former assignment as construction project engineer for the firm's Organic Chemicals Division, Mr. Colgan directed construction of the phenol facilities at Avon. He has been with Monsanto since 1950, and is a mechanical engineering graduate of Tri State College.

* * *

Thomas P. Simpson has been appointed assistant director of manufacturing, General Petroleum Corp.

On August 1, Mr. Simpson left his post as director of Socony-Vacuum Oil Co.'s research and development laboratories to assume his new position. He joined General Petroleum, a western affiliate of Socony, in 1924, shortly after his graduation from California Institute of Technology, transferring to the parent company in 1935 as chief development engineer of Socony laboratories.

Another General Petroleum promotion has placed **Curtis G. Cortelyou** as manager of the firm's new Ferndale, Wash., refinery, now under construction. **Victor M. Stanich** has been appointed chief engineer at the same location.

* * *

George Leppert is now manager of the newly-formed engineering research section of Monsanto Chemical Co.'s general engineering department. Mr. Leppert holds an MA in mechanical engineering from Illinois Institute of Technology, first joined Monsanto in 1947.

His new department will develop experimental data and new techniques on unit process operations, and find applications for new materials in chemical plant construction.

* * *

Richard C. Alden, chairman of the research planning board of Phillips Petroleum Co. has been elected first vice chairman of Committee D-2 on Petroleum Products and Lubricants of the American Society for Testing Materials. Mr. Alden succeeds **Dr. L. C. Beard, Jr.,** whose election as ASTM president was reported in these pages last month.

Mr. Alden has been a member of Committee D-2 since 1939 and of its Advisory Committee since 1946. He is also chairman of Section II on Volatility of Technical Committee A, chairman of Section D on Vapor Pressure of Research Division VIII, and secretary of Technical Committee H on Light Hydrocarbons.

* * *

Max F. Mueller will be chief technologist of Grace Chemical Co.'s nitrogen plant now under construction near Memphis, Tenn. Mr. Mueller, a chemical engineering graduate of the University of Michigan, is temporarily assigned to Grace's development department, until he can begin his new duties.

* * *

T. A. Petry has been named a supervisor in the development division of Socony-Vacuum Oil Co. In other Socony changes, **H. E. Rasmussen** becomes assistant supervisor, refining section, **D. P. Heath** becomes assistant supervisor, fuels and lubricants section, and **R. R. Halik** and **L. M. Browning** become research associates in the process development section.

* * *

Dr. G. F. Ordeman, manager of Standard Oil Co. (Ind.) Wood River, Ill., refinery, retired August 1 and was replaced by **H. E. Cotton,** formerly general superintendent of Standard's Casper, Wyo., refinery.

Mr. Cotton

Dr. Ordeman completes nearly 34 years service with Standard, having first joined the company in 1919 as a chemist at Whiting, Ind. He is a graduate of Washington and Lee and Johns Hopkins Universities.

Mr. Cotton became associated with Midwest Refining Co. in Casper in 1919 as chief draftsman, remaining on the staff when Standard took over the operations of the former company in 1923.

Replacing Mr. Cotton as general

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Personals

superintendent at Casper is **L. H. Butterworth,** formerly manager of operations and cost control division, manufacturing department, Chicago general offices. **F. C. Smith,** superintendent of that same department, has been moved up to manager.

* * *

Mr. Hartley

Fred L. Hartley, general superintendent of operations, Union Oil Co. of Calif., has been elected 1953-54 president of the California Natural Gasoline Association. He succeeds Warren H. Kraft, Honolulu Oil Corp.

A. C. Lyles, chief gas engineer, General Petroleum Corp., is vice president, and **E. R. Millet** is once again secretary-treasurer.

* * *

Robert L. Riggs is now the manager of the Omaha ammonia plant of Allied Chemical & Dye Corp.'s Nitrogen Division, and **Edward L. Ray** is the manager of the Division's new organic chemicals plant at Orange, Texas.

Mr. Riggs was formerly general superintendent at the division's Hopewell, Va., plant. Mr. Ray was assistant to plant manager at South Point, Ohio.

Both the Omaha and Orange facilities are expected to begin production early in 1954.

* * *

J. Porter Langfitt, senior vice president of Pure Oil Co., has relinquished his responsibilities over the firm's refinery operations. He will assume general administrative duties on a company-wide basis, and will continue to direct Pure's research and development labs, patent and engineering departments.

P. N. Gammelgard, Pure Oil refinery operations manager for the past four years, has been moved up to a new post, general manager of refinery division.

* * *

John D. Bartleson has joined the automotive products division of Ethyl Corp.'s Research and Engineering Department at Detroit. Formerly he specialized in hydrocarbon synthesis and the development of lubricating oil additives with the chemical research division of the Standard Oil Co. (Ohio).

* * *

Norval F. Meyers, managing director of Esso Petroleum Co., Ltd., London, has been appointed deputy coordinator of refining activities for Standard Oil Co. (N. J.). He completed his post graduate work at M.I.T., joining Standard Oil Develop-

(*To obtain more data on advertised products see page* 1232)

ment Co. in 1941. Since 1949 he has been with Esso Petroleum, working on construction and operation of the Fawley, England, refinery.

* * *

S. S. Johnson has been appointed a vice president of Mathieson Chemical Corp.'s Commercial Development Division. Graduate of Stevens Institute of Technology, Mr. Johnson was previously with M. W. Kellogg Co., E. B. Badger & Sons Co., and Stone & Webster Engineering Corp.

* * *

Dr. R. H. Crist is the new director of research, physical processes department, Carbide and Carbon Chemicals Co. He first joined Carbide in 1945, after working five years on the Manhattan (atomic bomb) project.

Dr. Crist

In 1927, Dr. Crist received PhD in physical chemistry at Columbia University, and joined the faculty of that school, serving there until his association with Carbide. He has authored numerous papers on photo-chemistry and reaction kinetics, and is a member of several professional and technical societies.

* * *

D. S. Alcorn has been transferred to Carbide & Carbon Chemicals Co.'s New York offices to assist in market development of chemicals being produced at the firm's new coal-hydrogenation plant at Institute, W. Va.

Mr. Alcorn has been with the company as a technical representative since 1943 in the Baltimore district office.

* * *

Joseph Guffy, California Research Corp., has been named temporary chairman to spearhead organizational activities of a proposed west coast society for exchanging information among those interested in mass, infrared and other fields of spectroscopy. Appointment was made at the 1953 West Coast Spectroscopic Meeting, held in April at Consolidated Engineering Corp.'s Pasadena, Calif. plant.

* * *

O. Norman Duncan, assistant superintendent of General Petroleum Corp.'s Torrance, Calif. refinery, retired April 1 after nearly 34 years service. He started in 1919 as a fireman at General's Vernon refinery.

* * *

Dr. Ray H. Boundy, Donald Williams and **Dr. J. D. Hanawalt** have been elected vice presidents of Dow Chemical Co. **Herbert D. Doan** and **Herbert H. Dow II** both grandsons of company founder Dr. H. H. Dow, have been named to the board of directors.

* * *

Dr. W. F. Tulley has been named group manager of product development and technical sales service, Naugatuck Chemical Division, U. S. Rubber Co. Formerly technical director of rubber chemicals and synthetic rubber development, Dr. Tuley joined the firm's general laboratory staff in 1928.

Other new Naugatuck research appointments include **Dr. L. H. Howland,** manager, synthetic rubber development; **Dr. P. M. Elliott,** manager, plastics development; and **F. L. Holbrook,** manager, rubber chemicals development.

* * *

Howard J. Philp has been appointed assistant manager of Ethyl Antiknock, Ltd., Canadian subsidiary of Ethyl Corp.

A mechanical engineering graduate of the University of Toronto, Mr. Philp has been with the Canadian firm since 1949 as a sales representative.

* * *

W. E. Lovejoy is the newly-named assistant to the manager in the safety division of Standard Oil Co. of Calif.'s personnel department.

* * *

John W. Miller is now export department manager of the Creole Petroleum Corp. His appointment enables former manager **Robert W. Miller,** to give full attention to his duties as vice president and director of the company.

Mr. John Miller is a graduate of Lafayette College and has been with Creole Petroleum since 1934.

* * *

W. B. Allen is the new president of Caminol Co. Other new officers chosen are **W. L. Marconi,** executive vice president; **V. L. Anderson,** treasurer; and **Robert Nibley,** secretary.

* * *

S. T. Raycraft has been named San Francisco district manager for Shell Chemical Corp., replacing **H. R. Nebeker,** now on special assignment to Shell Oil Co.

* * *

Jan Oostermeyer, who retired as Shell Chemical Corp. president in June, has been elected to the board of directors of Food Machinery and Chemical Corp.

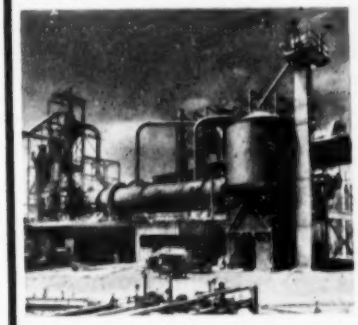
* * *

Frank Lammerman, superintendent of Union Oil of California's Cut Bank, Montana refinery, has been named vice president of the Cut Bank Chamber of Commerce. Previously, he had been a director.

what's NEW in Engineering

The shortage of engineers in all fields, according to three leading universities, will continue until 1955 or 1956. Then, a more balanced supply and demand picture should emerge—thanks to heavy registration of engineering students in the past two years. Meanwhile, one major university reports that in June they had over 4,000 jobs on file—open to 260 graduates.

Microscopic sea plants, called diatomaceae, are getting a lot of attention at Lompoc, California. Deposited geologic ages ago on the floor of what was then an island sea, their fossils are highly valued in many industries for filtering, refining, and other processes. To utilize



the huge deposits at Lompoc, Kaiser Engineers recently designed and built one of the largest and most modern Dicalite plants in the nation for Great Lakes Carbon Corp. We'll send you a reprint of an article in *Industrial and Engineering Chemistry* which tells the story of Lompoc's diatoms.

Chi-Teh Wang, N. Y. U. aeronautical engineering professor, has written a book on a new approach to elasticity. To be published by McGraw-Hill in August, *Applied Elasticity* presents useful analytical and numerical methods of applying fundamental elasticity theories.

Did you know that Kaiser Engineers is noted for widely diversified engineering talents? Departments include civil, structural, electrical, mechanical, architectural, process and production, mining and geology, metallurgical and chemical—all prepared to work closely together on any project. When you have a problem in engineering, call or write Kaiser Engineers Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, Calif.

(To obtain more data on advertised products see page 1232)

Alcoa's new Activated Alumina

. . . a gem of a desiccant for petroleum processing

Here, at last, is the ideal desiccant—ALCOA's latest and most efficient *Activated** Alumina, H-151 in ball form.

ALCOA Activated Alumina is the "old reliable" among drying agents, widely used in petroleum processing to dry liquids and gases to *lower* dew points than any other commercial adsorbent. Now the new H-151 series provides *longer* life . . . *higher* capacity . . . *lower* pressure drop . . . *greater* physical stability than ever before offered to the petroleum industry.

ALCOA Activated Alumina is commercially pure, highly inert, and possesses remarkably high resistance to crushing, abrasion, and thermal and mechanical shock. It will not change its form or properties—even when immersed in water—and can be reactivated almost indefinitely.

Call your nearest ALCOA sales office or write for complete data on this new, amorphous gel type Activated Alumina. Investigate its application to *your* processing problems today.

Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 716-H Alcoa Building, Pittsburgh 19, Pa.

Alcoa Chemicals

ALUMINUM COMPANY OF AMERICA

*Registered Trademark, Aluminum Co. of America

Don't forget ALCOA Utilitube*—aluminum instrument air tubing in long lengths.

LUBRICANT—
THE NORDSTROM SEAL OF APPROVAL

In any valve, if a small leak starts, high repair and replacement costs are coming up. And, if the valve is in an often-operated manifold, trouble comes to a head sooner.

Unless . . . .

. . . . the valve is a Nordstrom.

Nordstrom valves have an extra seal against those small leaks. In Nordstrom valves, an even film of plastic lubricant surrounds the valve ports, sealing off the line fluid and at the same time filling any minute point of wear. Further, since there is no seat or disk in the eroding stream of flow, the chances for wear are cut to a minimum.

It's that extra seal of lubricant that has won approval for Nordstrom valves in hundreds of services where other valves aren't quite good enough.
Rockwell Manufacturing Company, Pittsburgh 8, Pa.

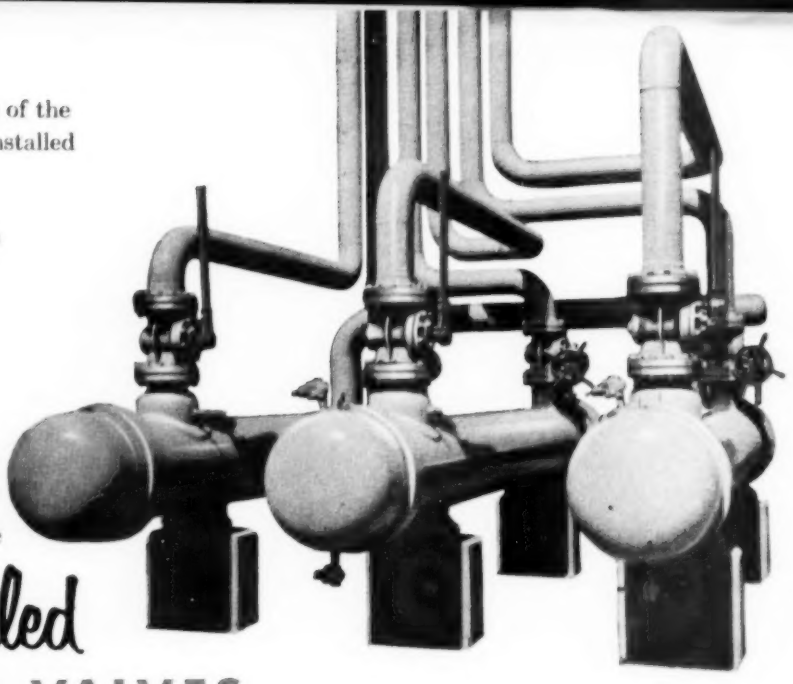
ROCKWELL Built Nordstrom Valves

Lubricant-Sealed for Positive Shut-Off

Another Rockwell Product

Regardless of the process, regardless of the piping arrangement, all valves are installed to do the same job:

TO CONTROL FLOW



Some valves do the job better than others. Some valves operate more easily than others in an emergency. Some valves stay tighter longer than others. That's because some (like these) are

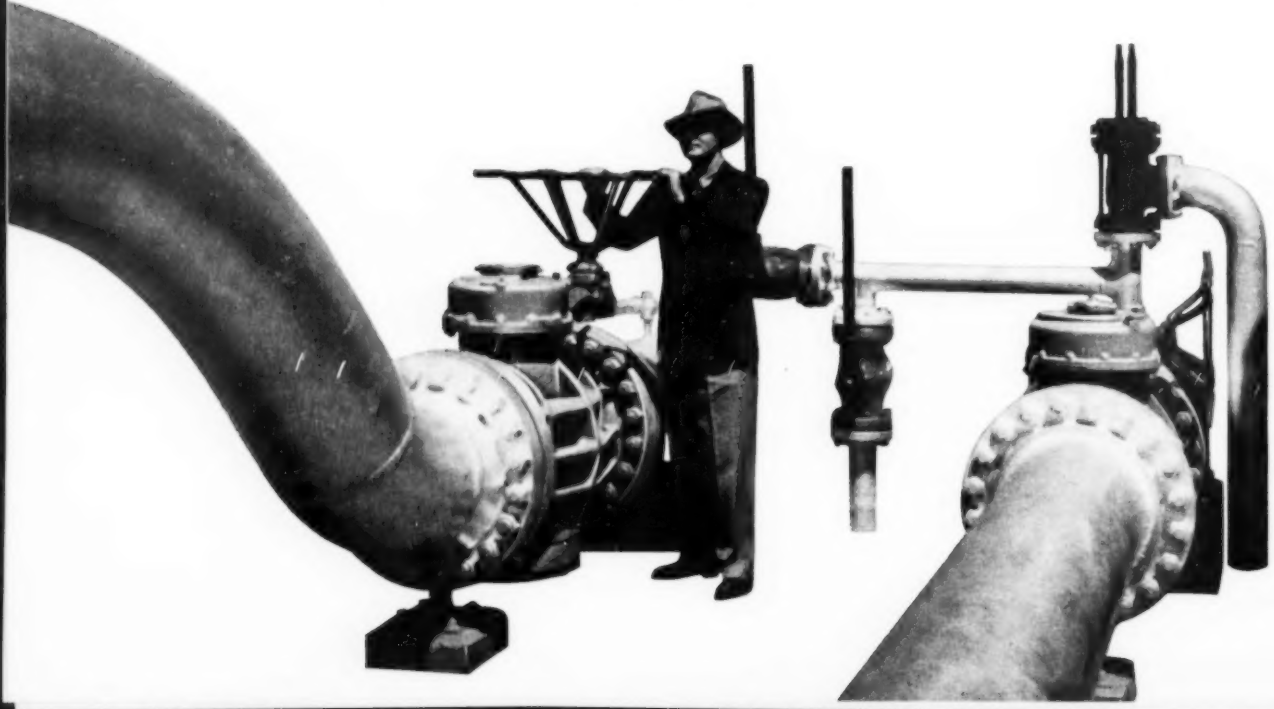
Lubricant-Sealed NORDSTROM VALVES

Nordstrom valves have a built-in lubricating system. The lubricant does two important things—it keeps the plug easy to turn so the valve shuts and opens in an instant when it is supposed to; it seals against the small leaks that become big and expensive and perhaps dangerous.
That's why Nordstrom valves

ARE YOUR BEST BUY

Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Nordstrom Valves Another Quality **ROCKWELL** Product



Lubrizol Promotes Three

Lubrizol Corp. has moved up three men to key posts in its manufacturing department. Roger Clapp becomes assistant manager of all manufacturing with headquarters in Cleveland, Ohio. Previously he was manager of the firm's Houston plant.

Mr. Clapp

Replacing Mr. Clapp at Houston is Kenneth Danskin. Matthew Payne has also been named as manager of Lubrizol of Canada, Ltd., a chemical additives subsidiary plant now under construction near Niagara Falls, Ontario.

Mr. Danskin

Mr. Payne

Mr. Clapp completed his graduate schooling at Purdue University in 1938, and has been with Lubrizol since 1941. He is a member of the Society of Automotive Engineers. Mr. Danskin came with the company in 1950, having previously served with The Texas Oil Co. since 1931. He is a member of the American Chemical Society. Mr. Payne joined the firm in 1949, and belongs to the American Institute of Industrial Engineers.

Monsanto Research Lab

Monsanto Chemical Co. is planning immediate construction of a four-story engineering research laboratory at its Nitro, W. Va. plant. To be completed by the middle of next year, the building will house equipment for process development and engineering research, as well as storage and office facilities.

Eight technologists will comprise the staff initially; later plans call for 15 men working on new processes and engineering methods for rubber and agricultural chemicals, oil additives and synthetic detergents.

Hydrocarbon Research in NCA

Hydrocarbon Research, Inc., has been elected to membership in the National Constructors Association, an organization composed of leading engineering and building firms engaged in design and construction of petroleum refineries, chemical plants and other industrial establishments.

GE Builds Control Plant

General Electric Co. is putting up a $5 million plant to manufacture general purpose controls at Bloomington, Ill.

Construction begins this year and operations are slated to start late in 1954. Products to be produced include electric starters, pushbuttons, compensators, etc. They're now being made at the firm's Schenectady, N. Y. works, but increasing demand has forced expansion of facilities. After the Bloomington works is complete, all engineering, sales and manufacturing activities of GE's General Purpose Control Department will be located there.

Koons Heads McDonald Design

Russel D. Koons, formerly with Bechtel Corp., now heads the newly-formed design and engineering department of McDonald Bros., Los Angeles construction firm.

George S. Ballew, formerly with Stone & Webster Engrg. Corp. will manage the service department for the petroleum industry.

Mr. Koons is a 16-year veteran in engineering and construction of oil refineries, chemical plants, etc. Mr. Ballew is a specialist in petroleum process design with 24 years experience.

Dunn New Peabody GM

New general sales manager of Peabody Engineering Corp. is John Dunn, formerly in charge of burner sales.

Mr. Dunn is now responsible for all sales divisions in the Western Hemisphere and territorial representative companies. He attended Webb Institute and joined the company in 1935 as a draftsman. He will continue to make his headquarters in New York City.

New Clark Eastern Mgr.

Robert R. McCartney has been named Eastern Division manager and director of Export Operations for Clark Bros. Co., division of Dresser Industries, Inc. He was district manager of the New York office.

Replacing Mr. McCartney in that post is Robert J. Spears.

A new sales office has also been opened by Clark in Philadelphia under direction of Ralph C. McDonald.

As divisional manager, Mr. McCartney will coordinate activities of the New York, Boston, Washington and Philadelphia offices. A graduate of Pratt Institute, he came with Clark in 1937.

Mr. Spears has been with the firm since 1938, when he graduated from St. Bonaventure College.

Mr. McDonald, who has been with the company for four years as a sales engineer, is a 1939 chemical engineering graduate of Northeastern University.

Martin Attapulgus Agent

C. O. Martin has been assigned to sales and technical service activities for Permagel, Attapulgus Minerals & Chemicals Corp.'s thickening agent for organic and aqueous media.

Mr. Martin has been closely associated for the past five years with laboratory development and application research work on the material, particularly in the lubricating grease field. He is a 1948 chemical engineering graduate from the University of Pennsylvania, and is a member of the American Chemical Society.

Stein Leeds & Northrup Head

I. Melville Stein has been elected president and D. H. Schultz replaces him as executive vice president of Leeds & Northrup Co.

Add Two To Catalytic Staff

Two high-level appointments have been made by Catalytic Construction Co. Anson W. Krickl is now assistant to president T. Ellwood Webster, and Wilfred Gains is assistant to vice president in charge of engineering W. E. Kelley.

Mr. Krickl

Mr. Krickl is a 1937 chemical engineering graduate of Yale, and formerly was with Stone & Webster Engineering Corp. Business development will be his chief task in the new post. Mr. Gains also holds a chemical engineering degree, from McMaster University in Hamilton, Ontario. Until has recent appointment he was senior project engineer with Vulcan Copper & Supply Co.

UOP Forms Catalyst Subsidiary

A new catalyst manufacturing subsidiary has been established by Universal Oil Products Co. in conjunction with Johnson, Matthey & Co.

J-M BLAZECRETE builds longer lasting refractory linings...

That's why it pays you to use this hydraulic setting refractory for temperatures to 3000F

Blazecrete* linings last longer because they resist spalling, withstand slagging action, and are not harmed by rapid temperature changes.

Thus you cut down on refractory maintenance costs—and you save on labor costs, too, because Blazecrete goes on fast. For troweling, just mix Blazecrete with water as you'd mix ordinary concrete . . . then slap-trowel it in place. When gunned, it adheres readily with a minimum of rebound loss. Either way, Blazecrete may be applied easily without laborious ramming or tamping.

Three types of hydraulic-setting Blazecrete are available. All harden on air curing, do not require prefiring. They are furnished as a dry mix—can be stored safely for use as needed.

3X BLAZECRETE—For temperatures through 3000F. Unusually effective for heavy patching, especially where brickwork is spalled or deeply eroded. Excellent for forge furnace linings, lime kilns, burner blocks, soaking pits, and industrial boilers.

STANDARD BLAZECRETE—For temperatures through 2400F. Makes repair work easier and less costly. Can be used by boiler manufacturers to replace fire clay tile in wall construction. Suitable for use in combination with 3X Blazecrete and L. W. Blazecrete.

L. W. BLAZECRETE—For temperatures through 2000F. An insulating refractory . . . light in weight, low in thermal conductivity. Adaptable and economical for many other applications.

Send for Brochure RC-28A on Blazecrete and its companion material, Firecrete*. . . the hydraulic-setting castable refractory for making special shapes and linings. Write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

*Reg. U.S. Pat. Off.

Whether you gun it... *or slap-trowel it...*

Johns-Manville **BLAZECRETE**

BUILDS BETTER REFRACTORY LININGS

Suppliers

Ltd., English platinum refiners. Construction is beginning now, and the plant is expected to be manufacturing Platforming catalyst for use in producing premium quality gasoline by mid-'54.

Known as Universal-Matthey Products, Ltd., the new firm has its headquarters in London. Initial manufacture is slated for Anglo-Iranian Oil Co. and Shell Refining & Marketing Co. Ltd. C. D. Sims, of UOP, has been named general manager of the new firm.

Pfaudler to Make Shell Trays

Pfaudler Co. has been named fabricating licensee for "Turbogrid" trays in an agreement with Shell Development Co.

The trays, a product of 20 years of Shell research, are a new vapor-liquid contacting type for distillation columns. As a result of the agreement, Pfaudler can now market all three major kinds of trays used in fractionating towers.

Personnel Changes

General American Transportation Corp.—Richard H. Lamberton to midwest manager, Plate and Welding Division, Chicago; Frank E. Seery to Pittsburgh district sales manager, same division.

Lummus Co.—James H. Curtis to assistant to the president, from general manager, manufacturing, General Petroleum Corp.

Graver Water Conditioning Co.—A. H. Honeck to district manager in Cleveland and Cincinnati from sales engineer in New York City.

Bechtel Corp.—Wilson E. Arthur to assistant in business development to vice president Charles T. Draney.

Chemical Construction Corp.—Dr. Martin de Sima to assistant sales manager.

Macco Corp.—L. E. Ash to general construction superintendent of the Refinery Division.

Kerotest Mfg. Co.—Russell H. Coe to sales representative in the Northeastern U. S.

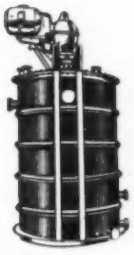
Girdler Co.—Harold E. Huber to technical sales department, Votator Division.

Barber-Colman Co.—Following men have been appointed to the Wheelco Instruments Division sales and service organization: Robert Unger, Chicago; Harold L. Dirkers and Leonard

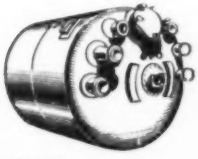
(To obtain more data on advertised products see page 1232)

HAYNES Alloy Sheet and Plate

Trade-Mark

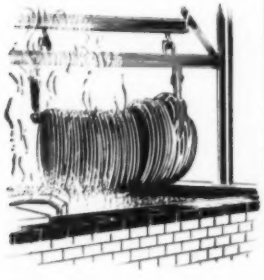


Evaporators



Autoclaves

Agitators



Pickling Equipment

For SEVERE SERVICE conditions

You can obtain sheet and plate of four different HAYNES alloys, all specially designed to combat certain severe service conditions, for the fabrication of processing equipment. The alloys are all strong and highly resistant to heat, oxidation, and chemical corrosion. The chart below will give you an idea of where each is most commonly used.

HAYNES alloy sheet and plate have been used successfully for many different types of fabricated equipment. Typical applications include reaction vessels, condensers, autoclaves, heat exchangers, evaporators, dryers, mixers, agitators, fans, and blowers. The alloys can be fabricated by deep drawing, spinning, pressing, forming, and welding.

All four HAYNES alloys are supplied in hot-rolled sheet and plate in thicknesses of 1 in. down to 24 U. S. Std. (0.025 in.). These materials are furnished annealed and pickled with a commercial No. 1 finish. If you wish further information about HAYNES alloy sheet and plate, contact the nearest Haynes Stellite Company district office.

USE SHEET OR PLATE OF	FOR RESISTANCE TO
HASTELLOY Alloy B (nickel-molybdenum-iron)	Hydrochloric acid, wet hydrogen chloride gas, sulphuric acid, phosphoric acid, organic acids, high temperatures.
HASTELLOY Alloy C (nickel-molybdenum-chromium-iron)	Nitric acid, free chlorine, acid salts, hydrochloric acid, sulphuric acid, phosphoric acid, organic acids, sulphurous acid, high temperatures.
MULTIMET Alloy (cobalt-chromium-nickel-iron)	Oxidation, high temperatures.
HAYNES Alloy No. 25 (cobalt-chromium-tungsten-nickel)	Oxidation, high temperatures, carburization, wet chlorine, nitric acid.

HAYNES TRADE-MARK *alloys*

"Haynes," "Hastelloy," and "Multimet" are trade-marks of Union Carbide and Carbon Corporation.

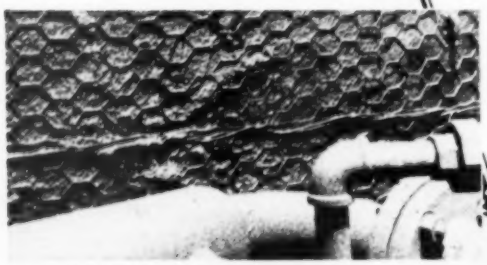
Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

Now — fast insulation protection

Laykold® WEATHERCOAT

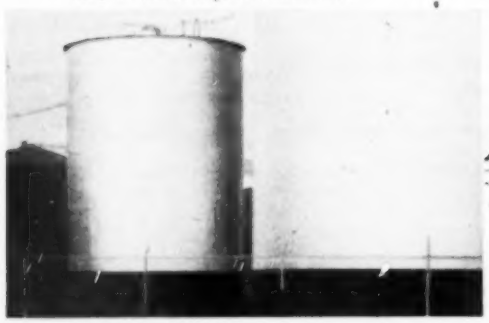
ASPHALT SPECIALTIES

sprays on! —in one-third the time required for troweling



• **FIRST COAT** bonds and protects wire netting.

• **SPRAY GUN** applies second coat, too, in fastest possible time.



• **TRIPLE-SEALED** and smooth, after wet brooming.

WEATHERCOAT—the standard of quality in the industry —for lasting protection

AMERICAN Bitumuls & Asphalt COMPANY

200 BUSH STREET
SAN FRANCISCO 4, CALIF.

Suppliers

V. Bloom, Detroit; William E. King, New York City; Lawrence S. Holbrook and Robert Hemman, Boston; Scott R. Babcock and Clyde Person, Rockford.

Warner Lewis Co. — Thomas R. Bradley to sales manager from sales promotion and advertising manager.

International Nickel Co.—John A. Marsh to vice president, in addition to his present position as head of all plant operations in the U. S.

Owens-Corning Fiberglas Corp.—Samuel E. Bosley to petroleum industry specialist from Tulsa branch manager.

Dresser Industries, Inc. —Ralph R. Newquist to president and general manager, Roots-Connersville Blower Division, from executive vice president.

General Controls Co. — Leonard Schnall to head a new sales and service office in Syracuse, N. Y.

Trane Co.—Roy L. Smith to Philadelphia sales office and James J. Callahan to Newark sales office, the latter returning after military service.

National Aluminate Corp.—William E. Conroy to West Coast manager of the Catalyst Division.

Oakite Products, Inc.—L. W. Cunningham to technical service representative in the company's new Beaumont, Texas, field territory.

Insul-Mastic Corp. — Abner H. Bagenstose to eastern regional manager and John J. Miller to midwestern regional manager, both operating from the Pittsburgh home office.

Ralph M. Parsons Co.—D. F. Gerstenberger, to vice president and manager of the newly-opened Tulsa office.

Johnston Pump Co. — (N. M. and Fresno)—Kenneth G. Lundie to president from vice president in charge of sales with the Pasadena firm of the same name.

American Cyanamid Co.—Richard G. Keppler to technical representative of the refinery chemicals department in New York City.

Branches, Distributors

The Trane Co. has opened a new sub-office at 115 Robert St., Fargo, N. D. with George W. Robbins as

(*To obtain more data on advertised products see page* 1232)

PROCESS EQUIPMENT NEWS

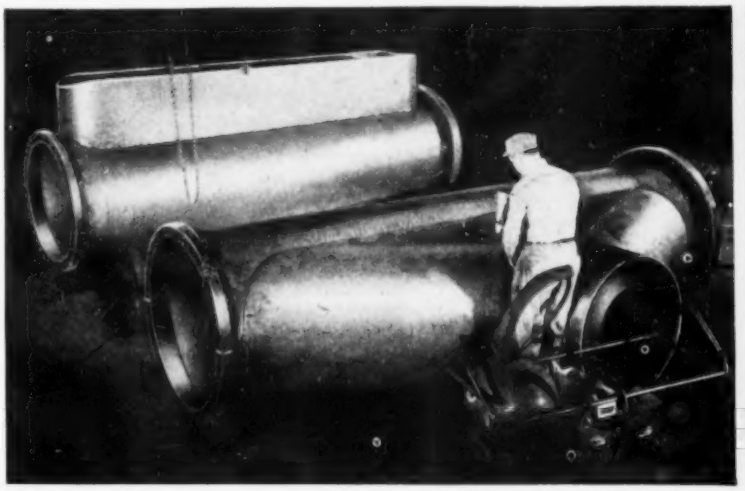
PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY AUGUST 1953

Exchangers Headed for Sumatran, African and Domestic Plants

Undergoing hydrostatic tests and inspection prior to shipment is this group of exchangers (see below) headed for several domestic refinery sites. Others, now being fabricated, will soon be shipped to a refinery in Palembang, Sumatra, and to South Africa.

The exchangers scheduled for South Africa are most unusual in that they will handle products at temperatures up to 1775°F. Specially-developed for this particular operation, the five units are being fabricated in the U.S. by Kellogg because of the firm's extensive experience in the welding of high alloy equipment.

Tubes and tube-sheets of the exchanger are being fabricated of Type 310 stainless steel. The shells are insulated on both the inside and outside. When in service the units will be employed for pre-heating feed gas going to a reformer that produces reaction gas for the synthesis of gasoline.



Minimum Pressure-drop in Unusual High-Vacuum Condensers

These are the shells for two of four special vacuum condensers scheduled for installation this summer in a major Gulf Coast refinery. When in service they will condense the overhead from a vacuum tower which is part of a three-stage pipe-still now under construction.

They are designed to operate on the shell side at 53.5 mm of mercury. To obtain a minimum pressure drop of 1.65 mm, an unconventional design is used which permits a cross flow on the shell side.

Products Enter Through 36" Nozzle

A mixture of hydrocarbons, steam and inert gases enters the first condenser through the 36-inch diameter nozzle shown in the photograph to the right of the welder. Temperature is reduced from 175°F to 93°F as it passes through the two condensers which are connected in series. In the process all of the hydrocarbon material and most of the steam is converted to a liquid state.

When completed, the 44-inch shells will contain 16-foot admiralty tubes on a $1\frac{1}{4}$" square pitch. Tube sheets will be of naval brass as will the tube supports. Remainder of these two-stage condensing units will be made of carbon steel.

INCREASED EXCHANGER CAPACITY . . .

SHOWN HERE is the shell fabrication section of Kellogg's heat exchanger facilities which has been streamlined for production-line manufacture of tubular heat transfer equipment. Other sections of the plant have also been rearranged and new fabricating equipment has been added to accelerate the production of the wide variety of units regularly coming into the shop.

For further information, details of methods, etc. contact

FABRICATED PRODUCTS DIVISION THE M. W. KELLOGG COMPANY

225 Broadway, New York 7, N. Y. or offices in Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London & Paris

KELLOGG PULLMAN

KELLOGG
EXCHANGERS
KELLOGG
THIN WALL ALLOY PIPING
KELLOGG
CLAD STEEL VESSELS
KELLOGG
CONDENSERS
KELLOGG
FRACTIONATING TOWERS
KELLOGG
PRESSURE PIPING
KELLOGG
DIGESTORS
KELLOGG
COOLERS

Here's a product that—

- Gives positive pressure relief!
- Saves vapor loss!
- Protects against fire!

BS&B COMBINATION VENT VALVE FLAME ARRESTER

MODEL VVFA

MODEL VVF

Has all the features of Model VVFA, except arrester bank. Can be a secondary relief valve with higher setting, or primary relief valve on non-flammable materials.

Patented Cantilever-Type Arrangement of rubber to metal seating makes for high vapor conservation...gives a tight seal in a hurry to cut off oxygen supply and extinguish flame. And this snuffing action is automatic!

Safe, Positive Protection to storage tanks containing flammable material is assured, thanks to exclusive BS&B design. And the high efficiency Vent Valve Flame Arrester has excellent flow characteristics!

Cleaning is Simple, since valve bonnet can be left on when taking out arrester bank. Valve stays in service during time arrester is being cleaned. Remember, with Vent Valve Flame Arresters maintenance time is cut in half, cost is cut even lower. Let us tell you how BS&B Vent Valve Flame Arresters may give you a more efficient, economical operation . . . with greater safety!

This bulletin tells the complete story. Write for it today!

Your Free Copy of Bulletin E-601 will tell you the seventeen outstanding features that make BS&B Vent Valve Flame Arresters your best buy. Or, ask your BS&B man to study your particular requirements. There's no charge, no obligation.

SAFETY BS&B HEADS OUR 60TH YEAR

See our exhibit at the Eighth National Instrument Exhibit, September 21 to 25, Sherman Hotel, Chicago Booths 148 to 150

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-DR

7500 East 12th Street Kansas City 26, Missouri

Suppliers

manager. New address of the firm's Duluth sales office is 414 Lyceum Bldg., Duluth 2, Minn. Telephone 7-4450.

Terry Steam Turbine Co. has named The Hank Thurstin Co. to handle sales of its turbines in Colorado, Wyoming, western Nebraska and northern New Mexico. Thurstin offices are located at 980 Forest St., Denver.

Rust-Oleum Corp. announces addition of Seaboard Mill Supply Co., New Brunswick, N. J., and E. Blankenship and Co., Marion, Ill., to its national distributor network.

Fisher Scientific Co. has opened a New England sales office at 10 Brattle St., Cambridge, Mass. Russell Bennett and Miss Norma Musto are in charge.

Duriron Co. has a new sales office in Needham, Mass., to serve the New England area. R. W. Henze heads the operation.

Marley Co. has moved its sales office from the Houston plant to a separate headquarters at 1601 Commerce Bldg., Houston. Roy W. Maze is in charge at the new location.

Bjorksten Research Laboratories has moved its Chicago office and laboratories to 1525 E. 53rd St.

Askania Regulator Co. has opened a new sales and service office at 1836 Euclid Ave., Cleveland, Ohio.

Shand & Jurs Co. has moved its New York City office to larger quarters at 342 Madison Ave.

Expansion, Transition

Integra-Leeds & Northrup Ltd., Birmingham, England is a new firm founded jointly by Leeds & Northrup Co., Philadelphia and S. A. Integra, Liege, Belgium. New company succeeds to business formerly conducted in Birmingham under name The Integra Co., Ltd., which was a branch of the Liege firm and for some years English agent for L&N products. Manufacture of both L & N and S. A. Integra products will be conducted at the Birmingham plant.

General American Transportation Corp. has purchased the land and buildings of James B. Berry and Sons Co. at Carteret, N. J. General American plans to use the space to expand the facilities of its present Carteret storage terminal.

ASME Reports Viscosity, Density Of Over 40 Lubricating Fluids

Pressure-Viscosity Report, prepared by the Research Committee on Lubrication, American Society of Mechanical Engineers; in two volumes; $10.00 for the set. American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

COMPREHENSIVE data on viscosity and density of more than 40 lubricating fluids at temperatures from 32° to 425° F. and at pressures up to 150,000 psi are contained in this recently published work. Bound in two volumes, the publication is a result of cooperative experimental work between ASME's Research Committee on Lubrication, numerous industrial firms, universities and government laboratories.

An advisory board composed of representatives from all these agencies contributed their services to insure suitable selection of test fluids and to advise on experimental procedures. Private petroleum and government labs made physical and chemical inspection tests on fluids to be sure fluids tested were properly identified. Pressure - temperature-viscosity-density measurements were carried out at Harvard University under direction of Professor R. V. Kleinschmidt.

This latter data has been entered on IBM punch cards, sets of which may be obtained from ASME's Research Department. Small quantities of many of the fluids have been stored in sealed ampules for future reference or testing if the need arises.

Oil Industry Data Filing System Revised Again

Decimal System for Classifying Data Pertaining to the Petroleum Industry, 3rd Edition, compiled by Profesor Lester C. Uren; 8½ x 11 in., 93 pp., indexed, stiff paper cover, $2.50. University of California Press, Berkeley and Los Angeles, Calif.

A VERY commendable job has been done, in the third edition of this work, in grouping and correlating subjects with respect to the petroleum industry's production activities. Unfortunately, the sections on manufacturing and processing, particularly on petroleum - derived chemical products, are not completely adequate.

The system is based on one originated by Dewey which subsequently has found wide use in libraries, government and industry files. Professor Uren's modification, however, does not seem to maintain the proper balance. For instance, the word "petrochemical" is not even included in the subject index, and while a whole major subdivision, (780.) has been set aside for the manufacture of carbon black, only a minor subdivision (759.6) has been used to discuss petroleum chemical manufacture, a business activity which turns out products estimated at $3.1 billions in value yearly.

All of which does not imply the system developed by Professor Uren is not a valuable one. It is, and can be made more so by expansion of the sections on petroleum manufacturing.

Formaldehyde Monograph Out in 2nd Edition

Formaldehyde, 2nd edition by J. Frederic Walker; 6 x 9 in., xvi+575 pp., indexed, stiff cloth binding, $12.00. Reinhold Publishing Corp., 330 W. 42nd St., New York 36, N. Y.

SPECIAL attention is given, in this second and completely revised edition, to the physical and thermodynamic properties of formaldehyde, methods of production, formation of hexamethylenetetramine and many other phases of manufacture and commercial use.

The book begins with a short history of the early development and uses of the compound, quickly launching into a discussion of production methods, commercial solutions, polymers, reactions with other compounds, etc. The numerous advances in formaldehyde chemistry and technology are covered in detail, with separate chapters on newly-found reactions.

Reference lists are given at the end of each chapter, and a comprehensive index concludes the work.

ASTM Okays 11 Process Tests and Specifications

AMONG the 63 new tentative specifications and tests approved by the American Society for Testing Materials at its 1953 annual meeting in Atlantic City, June 28-July 3 were eleven of specific interest to the petroleum processing industries.

All the new tentatives will be published later in the year in the 1953 Supplement to the ASTM Book of Standards. Copies of separate specifications will be available at a later date from Society headquarters, 1916 Race St., Philadelphia 3, Penna., at a nominal charge, usually 25c each, but slightly higher on standards over 16 pages in length.

Nine of the new tentatives were the work of Committee D-2 on Petroleum Products and Lubricants:

D 1261-53T, Test for Effect of Grease on Copper.

D 1262-53T, Test for Lead in New and Used Greases.

D 1263-53T, Test for Leakage Tendencies of Automotive Wheel Bearing Grease.

D 1264-53T, Test for Water Washout Characteristics of Lubricating Greases.

D 1265-53T, Sampling Liquefied Petroleum Gas. (Jointly with Committee D-3 on Gaseous Fuels).

D 1266-53T, Test for Sulfur in Petroleum Products and Liquefied Petroleum Gases by the CO_2-O_2 Lamp Method.

D 1267-53T, Test for Vapor Pressure of Liquefied Petroleum Gas.

D 1268-53T, Test for Unsaturated Light Hydrocarbons (Silver-mercuric nitrate absorption).

D 1269-53T, Test for Polarographic Determination of Tetraethyl Lead in Gasoline.

One other test was prepared by Committee D-9 on Electrical Insulating Materials. It is D 1275-53T, Test for Corrosive Sulfur in Electrical Insulating Oils.

Pipefitter's Manual Details Bending and Layout

Pipefitters Handbook by Forrest R. Lindsey; 4 x 6¾ in., 282 pp., stiff cloth cover, $6.00. Industrial Press, 148 Lafayette St., New York 13, N.Y.

THIS tabloid-sized quick reference volume for pipefitters contains a wealth of time-saving data on bending, screwed offsets, mitred joints and several types of fittings.

Numerous cutaway drawings and tables are used to help the pipefitter get quick answers to his everyday problems. A special section at the back of the book contains tables of squares, square roots, areas and functions, trig formulas and functions, etc., plus a dictionary of pipefitting terms.

Association Publications

Review of Current Research and Directory of Member Institutions, compiled by Engineering College Research Council of the American Society for Engineering Education; 6 x 9 in., xii + 329 pp., $2.50. Engineering College Research Council, 103 Mechanical Engineering, Pennsylvania State College, State College, Pa.

Cracking Catalyst Activity in the Presence of Hydrogen Sulfide, Research Bulletin 4, prepared by the Institute of Gas Technology; 8½ x 11 in., 28 pp., $3.50. Institute of Gas Technology, Technology Center, Chicago 16, Ill.

Government Publications

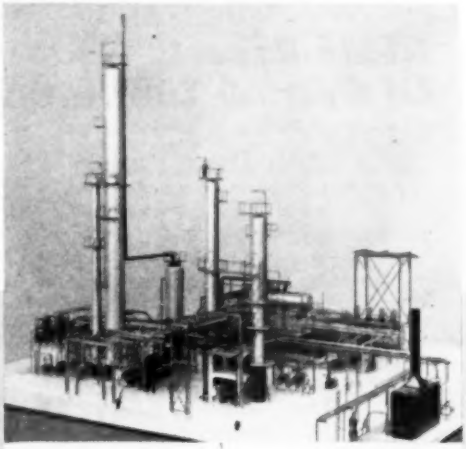
National Annual Survey of Aviation Gasoline and Aviation Jet Fuel, 1952 Production, Bureau of Mines Report of Investigations 4982, by O. C. Blade; 8 x 10½ in., 20 pp., heavy paper cover. Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

Early Operations of the Hydrogenation Demonstration Plant, Using Rock Springs, Wyo., Coal, Bureau of Mines Report of Investigations 4944, by Edwin A. Clarke, C. C. Chaffee and L. L. Hirst; 8 x 10½, 80 pp., heavy paper cover. Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

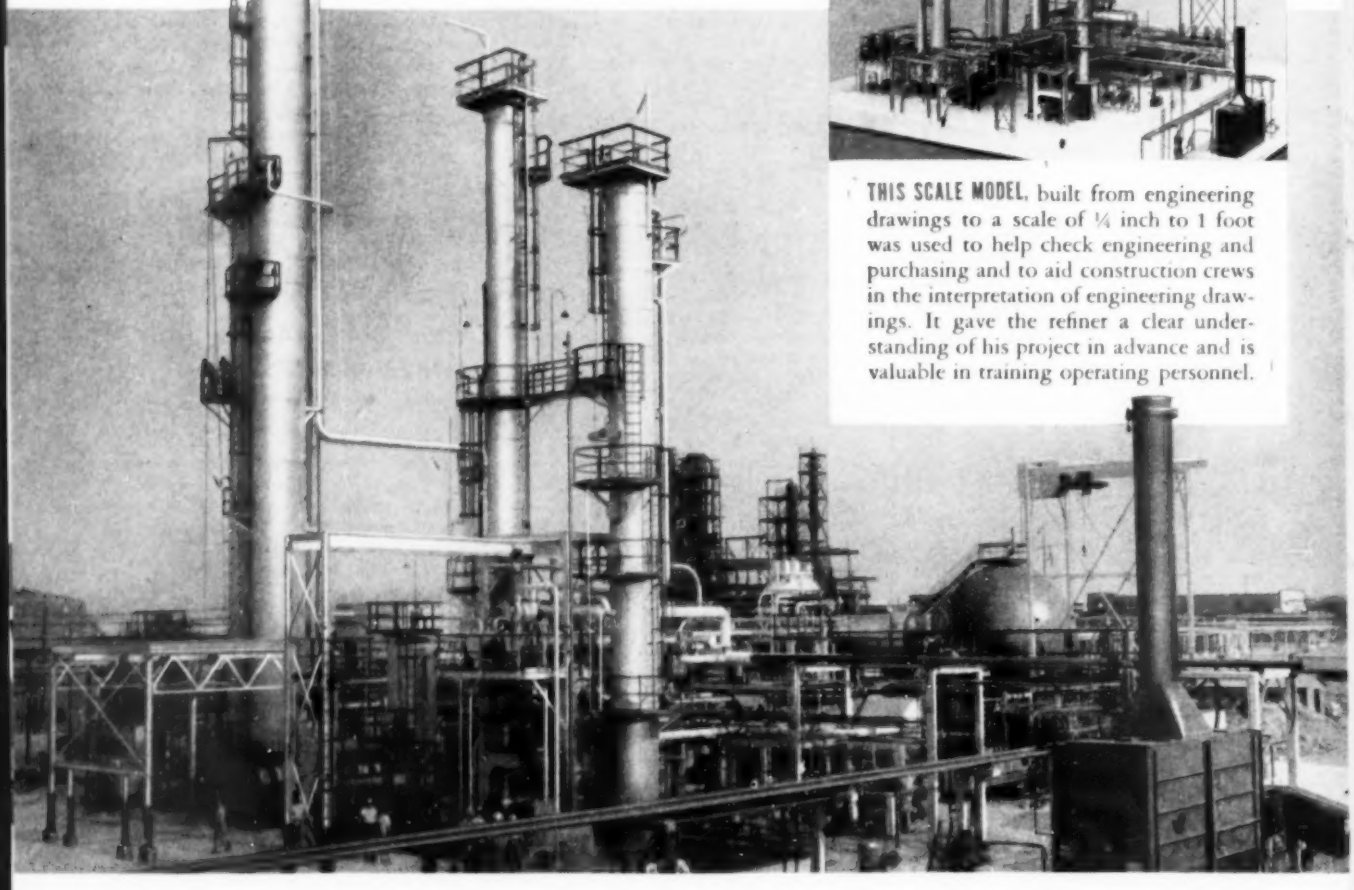
Petroleum Natural Gas Research Program, Fiscal Year 1952, Bureau of Mines Information Circular 7659, by R. A. Cattel and others; 8 x 10½, 45 pp., heavy paper cover. Bureau of Mines, U. S. Department of the Interior, Washington, D. C.

New Alkylation Unit Completed by McKee

THE COMPLETED UNIT shown below was recently put on stream. Capacity is 7,000 barrels of charge thruput per stream day. It is one of four alkylation units under construction simultaneously by McKee and is the 58th time this refiner has employed McKee engineering services.



THIS SCALE MODEL, built from engineering drawings to a scale of ¼ inch to 1 foot was used to help check engineering and purchasing and to aid construction crews in the interpretation of engineering drawings. It gave the refiner a clear understanding of his project in advance and is valuable in training operating personnel.



MCKEE ENGINEERING leaves no stone unturned, no method unexplored in our constant effort to design and construct the most efficient plant in the shortest possible time and at lowest possible cost.

The use of scale models is only one example of how this organization utilizes every device available to make sure "*McKee Engineering means Assured Results.*" That's why refiners all over the world use McKee services again and again.

ENGINEERING, PURCHASING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

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Headquarters: McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio.
Offices: New York • Tulsa, Oklahoma • Union, New Jersey • Washington, D. C.
British representatives of Metals Division: Head, Wrightson & Company, Ltd.
Canada: Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto 1, Ont.

Wide Variety of Topics in Program At 8th National Instrument Show

A FULL FIVE-DAY program of some 90 technical papers in 29 different sessions, plus three or four panel discussions and special clinics has been arranged for the Eighth National Instrument Conference and Exhibit, Sept. 21-25, 1953, at the Morrison and Sherman Hotels, Chicago, Ill. Attendance is expected to reach 15,000.

Under the general chairmanship of Robert R. Proctor, Pure Oil Co. Research Laboratories, Crystal Lake, Ill., the Chicago conference committees have set up a program to satisfy a wide diversity of interests. Among the papers expected to be of interest and value to instrument engineers in the petroleum processing industries are:

"General Problems in Sampling for Analysis Instrumentation," S. P. Spracklen, Carbide & Carbon Chemicals Co., Charleston, W. Va.

"Sample Handling Considerations with Continuous Infrared Analyzers," Glenn Smith, Smith, Baird Associates, Cambridge, Mass.

"Sampling Systems for Plant Analyzers," B. W. Thomas and R. L. Martin, Humble Oil & Refining Co., Baytown, Texas.

"The Application of Electronic Process Control to Oil Refineries," W. T. Marchment, Evershed & Vignoles Ltd., Cheswick, London, England.

"Study of Process Control by Phase Angle Loci Method," Yaohan Chu, Brown Instruments Div., Philadelphia, Penna.

"Continuous Carbon Monoxide Analyzer," M. D. Weiss, M. J. Schwartz, and B. J. Cooper, Taller & Cooper Inc., Brooklyn, N. Y., and Roger Gilmont, Emil Greiner Co., New York City.

"A Catalytic Combustion Hydrogen Gas Analyzer," D. S. Toomb, Jr., Oak Ridge National Laboratory, Tenn.

"Computers and Simulations Techniques in the Instrumentation Industry," Chalmer E. Jones, Beckman Instruments, Inc., Richmond, Calif.

"Building Block Analog Digital Data Processing Systems," G. S. Slocomb and D. N. Macdonald, Consolidated Engrg. Corp., Pasadena, Calif.

"Functional Design Considerations for an Inexpensive Analog Computer," R. H. List, R. E. Martin, and Wm. Hecox, Battelle Memorial Institute, Columbus, Ohio.

The popular pre-Conference Maintenance Clinic will again be held this year, with sessions beginning Friday, Sept. 18 at 1:00 p.m., and going on through Sunday afternoon.

Clinic Chairman George Larsen, of The Texas Co., Lockport, Ill., has set up three simultaneous schedules of eight subjects each, as follows:

Schedule A

Pyrometers (millivoltmeter type), mechanical and electrical potentiometers, electronic potentiometers, graphic panel instruments, control valve selection and maintenance, flow meters (electrical type), combustion control, and electric instruments.

Schedule B

Electronic potentiometers, graphic panel instruments, control valve selection and maintenance, pressure pilots and air relays, liquid level control, flow meters (electric), combustion control, and oxygen recorders.

Schedule C

Pyrometers (millivoltmeter type), thermocouples and lead wire, electrical instruments, graphic panel instruments, control valves, area type flow meters, combustion control, and self-operated controls.

PURE OIL'S BOB PROCTOR — he heads up Chicago Conference Committee for 8th National ISA affair

The Clinic is open to members of the Instrument Society of America and co-operating societies without charge. Non-members will be charged a $3.00 registration fee. Prior registration, not later than Sept. 14, is required. Fees must accompany registrations, which may be made by writing to P. V. Jones, Jr., manager, Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Penna. Hotel reservations must be made direct with the hotel. Classes will be held at the Morrison.

ASME Talks Processes, Materials at Houston

PAPERS on refinery processes, materials of construction, maintenance and inspection and plant structures and vessels form part of the bill of fare offered at the 1953 Petroleum Division conference of the American Society of Mechanical Engineers, at the Rice Hotel, Houston, Sept. 28-30.

Program items of particular interest to refiners include:

Processes:

"Salient Mechanical Features of Houdriflow," Shirk and Arden, Houdry Corp., Philadelphia.

"Fluid Catalytic Hydroforming Units—Their Mechanical Design," by R. A. Harang, M. W. Kellogg Co., New York.

"Continous Wax Molding," Ray Shannon, Magnolia Petroleum Co., Beaumont, Texas.

Materials:

"Cast Iron in the Refinery," W. J. Buxton, Standard Oil Co. (Ind.), Whiting.

"Why Use Pre-Stressed Concrete in the Refinery," Bell and DeVeaux, Esso Standard Oil Co., Bayway, N. J.

Inspection and Maintenance:

"Water Cleaning of Exchangers," W. B. Thomas, The Texas Company, Port Arthur.

"Preventive Maintenance of Refinery Compressors," J. R. Ware, Magnolia Petroleum Co., Beaumont, Texas.

"Monolithic Linings for Vessels and Pipes," W. A. Bradbury, Humble Oil & Refining Co., Baytown, Texas.

"Factors Influencing the Performance of Internal Insulating Linings," Vogrin and Murphy, M. W. Kellogg Co., New York.

"The ASME Pressure Vessel Code—A Joint Effort for Safe Construction," a panel discussion led by E. O. Bergman, C. F. Braun & Co., Alhambra, Calif.

Oil Man's Calendar

SEPTEMBER

American Chemical Society, fall meeting, Conrad Hilton Hotel, Chicago, Sept. 6-11.

American Institute of Chemical Engineers, regional meeting, Fairmont and Mark Hopkins Hotels, San Francisco, Calif., Sept. 13-16.

National Petroleum Ass'n, annual meeting, Traymore Hotel, Atlantic City, N. J., Sept. 16-18.

Chemical Market Research Ass'n, fall meeting, Pocono Manor Inn, Pocono Manor, Pa., Sept. 17-18.

Instrument Society of America, 8th national conference and exhibit, Hotels Sherman and Morrison, Chicago, Ill., Sept. 21-25.

Natural Gasoline Ass'n of America, fractional analysis seminar, Texas Hotel, Ft. Worth, Tex., Sept. 21-22.

Western Petroleum Refiners Ass'n., regional meeting, Hotel Henning, Casper, Wyo., Sept. 24-25.

American Society for Testing Materials, Committee D-2 meeting, Shoreham Hotel, Washington, D. C., Sept. 27-Oct. 2.

American Society of Mechanical Engineers, petroleum division, annual conference, Rice Hotel, Houston, Sept. 28-30.

OCTOBER

California Natural Gasoline Ass'n., 28th annual meeting, Ambassador Hotel, Los Angeles, Oct. 8-9.

Pac aging Institute, 15th annual Forum, Hotel Statler, New York City, Oct. 12-14.

Scientific Apparatus Makers Assn., mid-year meeting of recorder-controller section, Seaview Country Club, Absecon, N. J., Oct. 14-16.

Society of Industrial Packaging and Materials Handling Engineers, exposition, technical short course and competition, Mechanics Hall, Boston, Mass., Oct. 18-24.

Western Petroleum Refiners Ass'n, regional meeting, Garrett Hotel, El Dorado, Ark., Oct. 22-23.

Natural Gasoline Ass'n. of America, regional meeting, Blackstone Hotel, Tyler, Texas, Oct. 24.

Association of Consulting Chemists and Chemical Engineers, annual meeting (25th anniversary), Hotel Belmont-Plaza, New York City, Oct. 27.

NOVEMBER

Packaging Association of Canada, annual convention, Toronto, Nov. 1-7.

American Oil Chemists Society, fall meeting, Sherman Hotel, Chicago, Nov. 2-4.

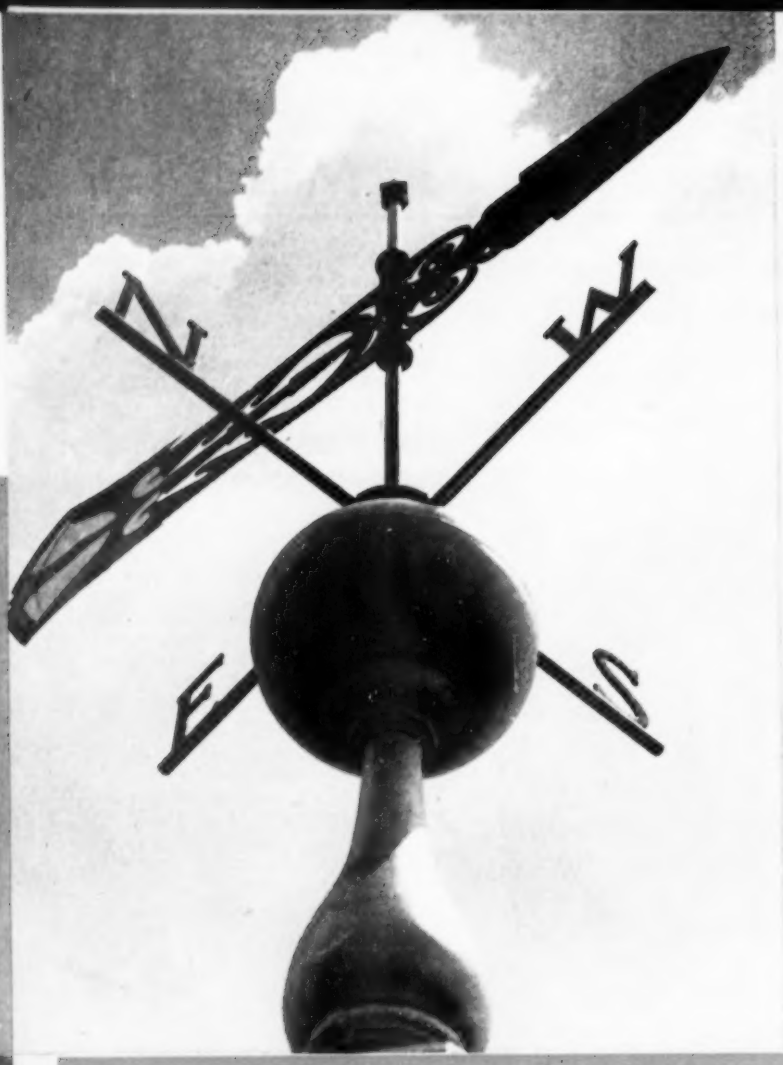
American Institute of Electrical Engineers, fall general meeting Hotel Muehlebach, Kansas City, Nov. 2-6.

Society of Automotive Engineers, national fuels and lubricants meeting, Conrad Hilton Hotel, Chicago, Nov. 5-6.

American Petroleum Institute annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Nov. 9-13.

Natural Gasoline Ass'n. of America, regional meeting, Herring Hotel, Amarillo, Texas, Nov. 21.

Chemical Industries Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa., Nov. 30-Dec. 5.



A Four-Way Selection

This photograph of a weather vane seems a good way to point out the fact that there are four different types of Midwest Welding Elbows (see below). These are more types than are manufactured by any other company. This greater selection is important to users of welded piping because it gives the engineer greater latitude in piping design and permits improvements and economies not otherwise possible in welded piping systems. For more information on this subject, ask for Catalog 48.

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Main Office: 1450 South Second Street, St. Louis 4, Mo.

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Sales Offices:

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Los Angeles 33—520 Anderson St. • Houston 2—1213 Capitol Ave.

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MIDWEST "LONG TANGENT"

Same radius as ASA but tangent equal to 25% of nominal pipe size on each end. Saves pipe, layout and welding time. Costs no more than ASA. Sizes to 24".

ASA STANDARD

Dimensions conform to applicable size range of American Standard for Butt-Welding Fittings. ASA B16.9. Tolerances much less than allowable. Sizes to 26".

SHORT RADIUS

Recommended where space is limited. Sizes to 30". Also available with "Long Tangents" in sizes 14" to 30".

MIDWEST REDUCING

Takes the place of a straight size elbow and a reducer. Eliminates one weld, reduces pressure drop, easier to insulate. Sizes to 12", reductions to half size.

MIDWEST WELDING FITTINGS

IMPROVE PIPING DESIGN AND REDUCE COSTS

4103

Distributors' Stocks Uncertain Factor In Winter Outlook for Heating Oils

REFINERS today, in the peak of seasonal consumption of motor gasoline, are two-thirds of the way through the period in which they normally build up inventories of distillate fuels and kerosine against the requirements of the 1953-1954 heating season. The trend for each product seems to be:

The rate of withdrawals of gasoline stocks slowed up during July because of the high plant output and the high rate of yield from crude. If this continues, stocks by November will be considerably higher than earlier estimated. Consumption continues to run 8-9% above a year ago.

With heating oils (kerosine and distillate fuels) the replenishing of distributors' stocks (secondary inventories) is lagging because of market uncertainties, and it may be September before this movement is in full swing and the effect on primary stocks determined.

Heating oil stocks east of California in mid-July were 13.5% greater than in 1951 (a more normal year for comparison than '52 with the strike). Statistically they are not considered out of balance with coming requirements, particularly if the early part of the winter should be colder than normal.

Indicated crude runs to stills in July for the U. S. were 7,143,000 b/d avg., highest of the year.

Gasolines: U. S. refiners' gasoline stocks July 25 were 143,446,000 bbls., and east of California 123,734,000 bbls. This was 9.5% higher than on a comparable date in 1951 for the U. S., and 7.4% for the area east of California. The difference in volumes for the two years has expanded in the last month. On June 27 U. S. stocks were 7.8% higher than on June 30, '51 and east of California they were 5.4% higher.

In the four weeks to July 25, gasoline stocks for the U. S. were reduced 3,510,000 bbls., and east of California 2,847,000 bbls. In the corresponding four weeks in 1951, withdrawals were 5,837,000 bbls. for the U. S. and 4,921,000 bbls. east of California. In 1952, when refiners were operating on recognized low inventories and were taking care of demand largely from current production, withdrawals were 2,617,000 bbls. for the U. S. and 1,884,000 bbls. east of California for a corresponding four-week period.

The lower withdrawal rate this year, contrasted with 1951, is due to the high rate of production, which comes both from high crude runs and a high gasoline yield (over 45% indicated in July). Indicated refinery production of gasoline from crude in July was 3,252,000 b/d avg. and total supply 3,612,000 bbls, 6.6% greater than in July '52.

In early November, 1951, U. S. gasoline stocks got down to around 119,500,000 bbls. This was a reduction of only around 11,000,000 bbls. from July 28. In 1952 stocks by early November had increased several million barrels from July 26. With total gasoline stocks this year 143,446,000 bbls. on July 25, indications are that the industry will start the winter buildup with by far the highest gasoline stocks on record, even with consumer demand continuing high through the fall. Tankage may be required for gasoline that some refiners will wish was available for heating oils.

Heating Oils: With a 9.5% increase in domestic oil burner installations by the end of the year, a 10% increase in consumer demand is estimated this 1953-54 season, with normal temperatures.

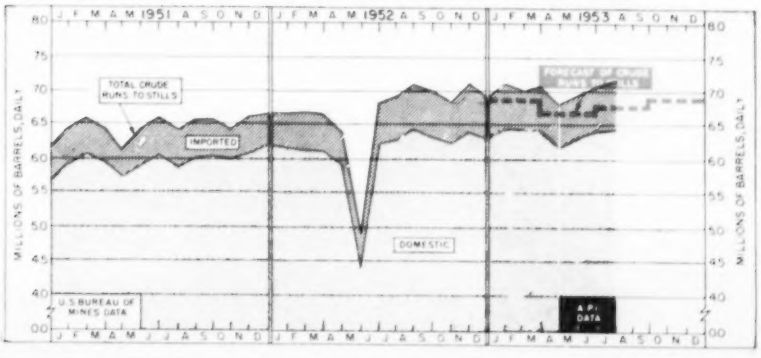
Total U. S. heating oil stocks July 18 were 124,556,000 bbls., nearly 15% larger than on July 21, '51. East of California, inventories were 13.5% larger. Rates of difference vary greatly with refining districts (Table 1). Largest rate of increase in 1953 over 1951, excluding California, is in the East Coast and Gulf Coast combined area. Heating oil stocks in the Ind.-Ill.-Ky. district were less in volume than in 1951. At this date, heating oil inventories are not out of line with coming requirements.

Residual Fuels: Demand at refineries for residual fuels for 6 months has been moderately above supply as evidenced by firmer markets. This is the one volume product where the long-range trend of stocks is downward. In late July, stocks east of California were about 4,500,000 bbls. less than in '52 and for the U. S. 2,266,000 bbls. lower.

Table 1—Refinery Stocks of Heating Oils (Distillates and Kerosine) by Refinery Districts, July 21, '51, July 19, '52 and July 18, '53

	July 18, '53	July 19, '52	Change '53 from '52 Amount	Change '53 from '52 %	July 21, '51	Change '53 from '51 Amount	Change '53 from '51 %
East Coast	42,964	36,084	+ 6,880	19.1	37,794	+ 5,170	13.7
Gulf Coast	26,779	16,348	+ 10,431	63.8	20,271	+ 6,508	32.1
Total Coastal	69,743	52,432	+ 17,311	33.0	58,065	+ 11,678	20.1
Appalachian	2,468	2,378	+ 90	3.8	2,618	— 150	5.8
Ind.-Ill.-Ky.	21,634	21,367	+ 267	1.2	22,370	— 736	3.3
Okla.-Kans.-Mo.	12,607	11,630	+ 977	8.4	10,281	+ 2,326	22.6
Other Inland	5,788	5,783	+ 5	0.1	5,537	+ 251	4.5
Total Inland	42,497	41,158	+ 1,339	3.2	40,806	+ 1,691	4.1
Total East of Cal.	112,240	93,590	+ 18,650	19.9	98,871	+ 13,369	13.5
California	12,316	8,899	+ 3,417	38.4	9,611	+ 2,705	28.2
Total U. S.	124,556	102,489	+ 22,067	21.5	108,482	+ 16,074	14.8

Fig. 1—Crude Runs at Peak for '53



Crude Runs to Stills

Daily Average (1000 bbls.)

	Domestic	Foreign	TOTAL
July '53 API*	6,483	660	7,143
July '52 BM	6,338	589	6,927
Change	+145	+71	+216
% Change	2.3	11.9	3.1

*Through July 25

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mos. '53*	1,147,846	113,711	1,261,557
6 Mos. '52	1,062,670	92,371	1,155,041
Change	+85,176	+21,340	+106,516
% Change	8.0	23.1	9.2

*May and June estimated from API data.

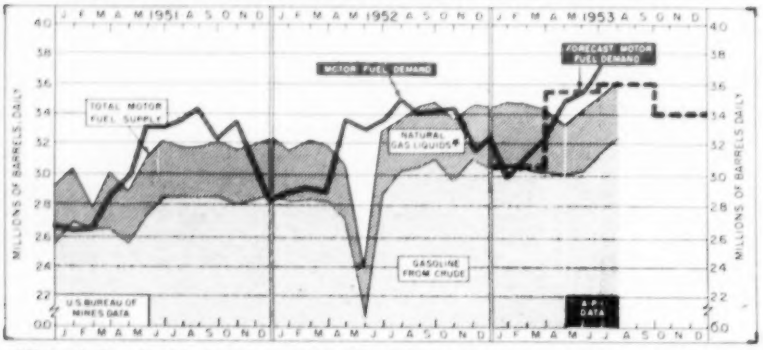
BM Forecast of Crude Runs to Stills, 1953
(Dec. 26, 1952; 1000 bbl. avg. by quarters)
1st Q., 6,920 2nd Q., 6,750 3d Q., 6,819 4th Q., 6,972

Yields on Crude Runs to Stills

	Gasoline %	Kerosine %	Dist. Fuels %	Resid. Fuels %
July '53 API*	45.5	4.7	29.7	17.7
June '53 API	45.1	4.7	29.9	17.3
May '53 API	43.6	5.0	30.9	17.5
July '52 BM	43.2	5.1	31.2	17.7

*Through July 25

Fig. 2 Refinery Gasoline Demand Levels Off



*Natural Gas Liquids include gasoline blended at refineries, and that used as finished motor fuel.

Fig. 3—Smaller Drop in "Gas" Stocks in July

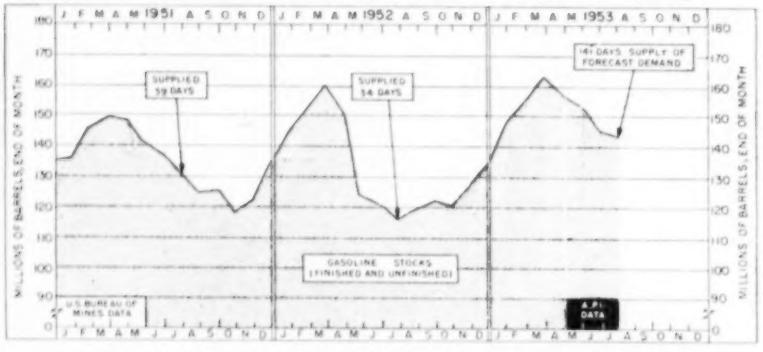


Fig. 4—Lower Yield Rates in Heating Oils

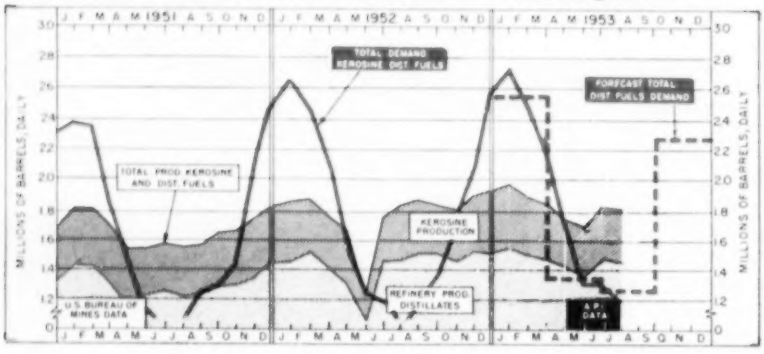
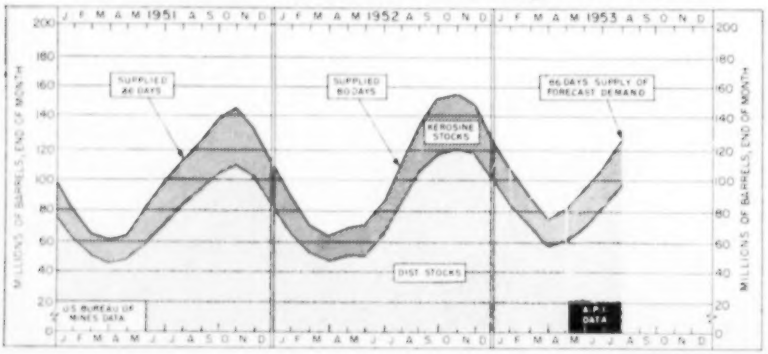


Fig. 5—Seasonal Climb in Heating Oil Stocks



Motor Fuel Supply

Daily Average (1000 bbls.)

	Gasoline from Crude	Natural Blended Used Direct	TOTAL
July '53 API*	3,252	360	3,612
July '52 BM	3,012	376	3,388
Change	+240	—6	+224
% Change	8.0	4.3	6.6

*Through July 25

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mos. '53*	555,493	68,372	623,976
6 Mos. '52	488,803	67,353	556,156
Change	+66,800	+1,020	+67,820
% Change	13.7	1.5	12.2

*May and June estimated from API data

Motor Fuel Demand

Including Exports
Daily Average (100 bbls.)

July '53 API*	3,710
July '52 BM	3,508
Change	+202
% Change	5.8

*Through July 25

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mos. '53	613,939
6 Mos. '52	570,353
Change	+43,586
% Change	7.6

*May and June estimated from API data

BM Forecast of Motor Fuel Demand, 1953

(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 3,055 2nd Q., 3,560 3d Q., 3,609 4th Q., 3,462

Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

July '53 API*	143,446
June '53 API	145,907
May '53 API	152,592
July '52 BM	116,566

*July 25

Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
July '53 API*	334	1,479	1,813
July '52 BM	358	1,475	1,833
Change	—24	+4	—20
% Change	6.7	0.3	1.1

*Through July 25

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mos. '53*	67,888	265,708	333,596
6 Mos. '52	63,527	246,282	309,809
Change	+4,361	+19,426	+23,787
% Change	6.9	7.9	7.7

*May and June estimated from API data

Heating Oils Demand

Daily Average (1000 bbls.)

	Kerosine	Dist. Fuels	TOTAL
July '53 API*	216	930	1,146
July '52 BM	218	855	1,073
Change	—2	+75	+73
% Change		8.8	6.8

*Through July 25

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mos. '53*	67,545	282,459	350,004
6 Mos. '52	67,354	269,569	336,923
Change	+191	+12,890	+13,081
% Change	0.3	4.8	3.9

*May and June estimated from API data

BM Forecast of Heating Oils Demand, 1953

(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 2,566 2nd Q., 1,352 3d Q., 1,250 4th Q., 2,272

Heating Oil Stocks

(1000 bbls. end of month)

	Kerosine	Dist. Fuels	TOTAL
July '53 API*	30,312	98,114	128,426
June '53 API	27,349	84,395	111,744
May '53 API	25,628	71,695	95,323
July '52 BM	27,387	85,775	113,162

*July 25

Fig. 6—Moderate Drop in Residual Demand

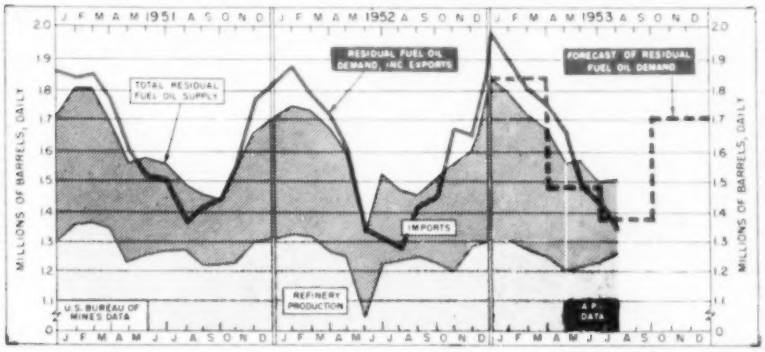
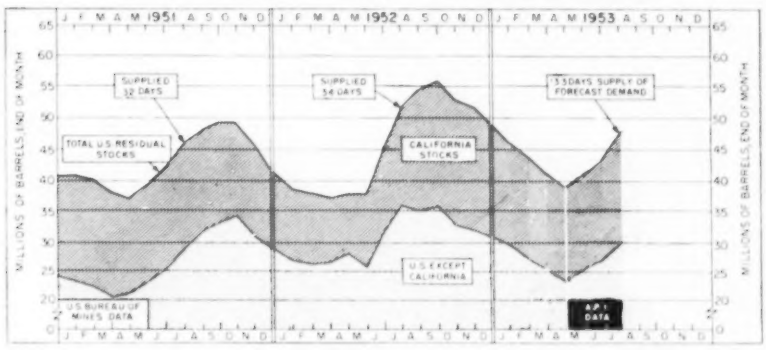


Fig. 7—Sharper Gain in Residual Stocks



Residual Fuels Production

Daily Average (1000 bbls.)

	Refinery Output	Imports	TOTAL
July '53 API*	1,243	297	1,540
July '52 BM	1,237	248	1,485
Change	+26	+19	+45
% Change	2.1	7.8	3.0

*Through July 25

Total (1000 bbls.)
(Bureau of Mines Data)

6 Mos. '53*	226,421	71,021	297,442
6 Mos. '52	224,082	67,939	292,021
Change	+2,339	+3,082	+5,421
% Change	1.0	4.5	1.9

*May and June estimated from API data

Residual Fuels Demand

Daily Average (1000 bbls.)

July '53 API*	1,342
July '52 BM	1,285
Change	+57
% Change	4.4

*Through July 25

Total Demand (1000 bbls.)

6 Mos. '53*	303,262
6 Mos. '52	292,538
Change	+10,724
% Change	3.7

*May and June estimated from API data.

BM Forecast Residual Fuels Demand, 1953
(Dec. 26, 1952; 1000 b/d avg. by quarters)
1st Q., 1,844 2nd Q., 1,494 3d Q., 1,370 4th Q., 1,707

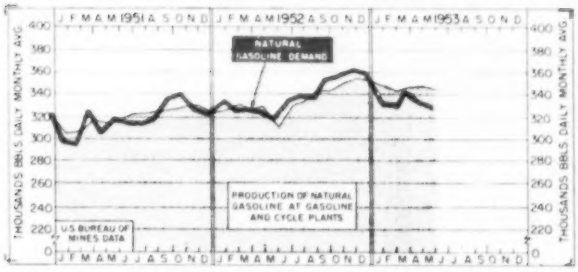
Residual Fuel Stocks

1000 bbls. end of month

	U.S. Except California	TOTAL U.S.
July '53 API*	20,143	48,886
June '53 API	27,263	44,185
May '53 API	25,814	41,572
July '52 BM	36,018	52,245

*July 25

Fig. 8—Supply and Demand of Natural Gas Liquids



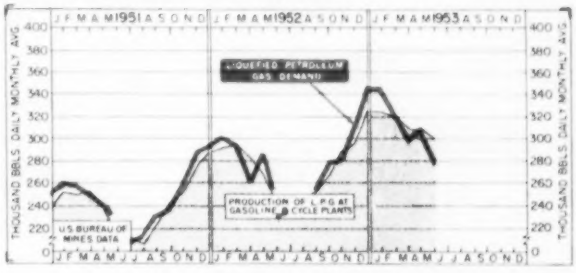
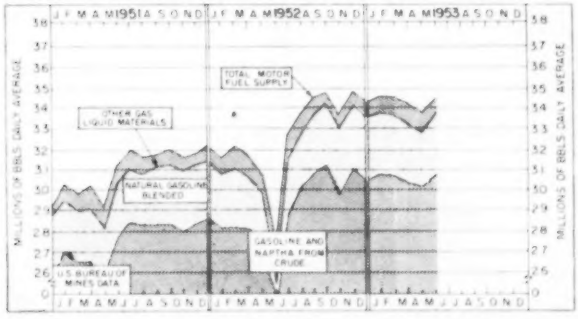


Fig. 9—Makeup of U. S. Motor Fuel Supply



(Figures in table in 1000 bbls./day average)

	Gasoline & Naphtha from Crude	Natural Blended	Other Gas Liquid Materials	Total Motor Fuel Supply
May '53	3,100	266	93	3,459
Apr. '53	3,012	270	98	3,380
Mar. '53	3,031	288	97	3,416
May '52	2,057	239	107	2,403

Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

	Supply* (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL	Demand** (1000 bbls./day avg.) Natural Gasoline	LPG	TOTAL
May '53*	342	300	642	331	279	610
May '52	310	238	548	317	227	544
Change	+32	+62	+94	+14	+52	+66
% Change	10.3	26.1	17.1	4.4	23.0	12.1
	Total Supply (1000 bbls.)			Total Demand (1000 bbls.)		
5 Mos. '53*	52,030	47,351	99,381	50,730	46,734	97,464
5 Mos. '52	49,479	41,868	91,347	49,281	41,074	90,355
Change	+2,551	+5,483	+8,034	+1,449	+5,660	+7,109
% Change	5.2	13.1	8.8	2.9	13.8	7.9

Stocks, End of Month (1000 bbls.)

	By type of product (At gasoline plants and terminals only) LPG	Natural Gasoline	Con-densate	Finished Gasoline†	By Location Gasoline Plants	Refin-eries	Total
May '53	2,808	3,411	237	1,185	7,641	2,718	10,359
Apr. '53	2,161	2,940	272	1,282	6,655	2,194	8,849
Mar. '53	2,131	2,621	265	1,379	6,396	1,872	8,268
May '52	2,066	2,955	263	1,052	6,336	2,910	9,246

*Supply includes receipts from refineries as well as current production from natural gasoline and cycling plants. Receipts from refineries in May included 167,000 bbls. of natural gasoline.

**Demand does not include liquefied refinery gases produced for fuel and chemical purposes, which totaled 2,787,000 bbls. in May.

†Includes naphtha and other products.

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data offered in this issue's advertisements:

ACTIVATED ALUMINA, in ball form: Complete data; Aluminum Co. of America. See adv't p. 1216.

ADDITIVES, gasoline: Booklets; Eastman Chemical Products, Inc., See adv't p. 1153.

ADDITIVES, lubricating oil: Information on Santolube; Monsanto Chemical Co. See adv't p. 1113.

ADDITIVES, oxidation, inhibitors for insulating oils: Technical bulletin; Shell Chemical Corp. See adv't p. 1143.

ADSORBENTS, fullers earth and activated bauxites: Information; Attapulgus Minerals & Chemicals Corp. See adv't p. 1251.

AIR PREHEATERS: Complete details; The Air Preheater Corp. See adv't p. 1212.

ALLOY SHEET AND PLATE: Information; Haynes Stellite Co. See adv't p. 1219.

ALLOYS, for High Temperature service: High Temperature Work Sheet; The International Nickel Co., Inc. See adv't p. 1237.

BURNERS, fuel oil, gas: Detailed information; National Airoil Burner Co., Inc. See adv't p. 1252.

CATALYTIC REFORMING: Booklet The Atlantic Refining Co. See adv't pps. 1140-1141.

CATALYST CARRIERS, alundum: Samples; Norton Co. See adv't p. 1148.

CATLYSTS, synthetic fluid-type, microspheroidal and ground: Descriptive information; The Davison Chemical Corp. See adv't pps. 1146-1147.

CHLORINATION EQUIPMENT, for slime control in process or cooling water: Information; Wallace & Tiernan Co., Inc. See adv't p. 1211.

COMPRESSED GAS TRANSPORTS, motorized trucks: Details; The Taylor-Wharton Iron & Steel Co. See adv't p. 1246.

COMPUTERS, shaft monitor: Information; Engineering Research Associates. See adv't p. 1240.

DESALTING, electric: Booklet; Petrolite Corp. See adv't p. 1259.

DRIERS, for instrument air: Help on problems; Pittsburgh Lectrodryer Corp. See adv't p. 1142.

ELECTRIC MOTORS, explosion-proof, totally enclosed: Bulletin; U. S. Electrical Motors, Inc. See adv't p. 1208.

ENGINEERING SERVICES: Brochure PP20-1; Arthur D. Little, Inc. See adv't p. 1135.

EXPANSION JOINTS, universal packless type: Bulletin 35-51A; American District Steam Co., Inc. See adv't p. 1139.

FABRICATION of vessels and heat exchangers: Information; A. O. Smith Corp. See adv't pps. 1204-1205.

FILTERS, for fluids: Bulletin No. 1152-P; Ronningen Manufacturing Co. See adv't p. 1236.

FIRE PROTECTION, all types: Literature, "The ABC of Fire Protection;" "Automatic" Sprinkler Corp. of America. See adv't p. 1119.

FIRE PROTECTION, by foam system: Booklet, "Foam and How to Use It;" National Foam System, Inc. See adv't p. 1244.

FITTINGS, valves, pipe and pumps jacketed: Bulletin J-50; Hetherington & Berner Inc. See adv't p. 1248.

FITTINGS, welded: Catalog W-3; Bonney Forge & Tool Works. See adv't p. 1243.

FITTINGS, welded: Catalog 48; Midwest Piping Co., Inc. See adv't p. 1226.

FLAME ARRESTERS, vent valve: Bulletin E-601; Black, Sivalls & Bryson, Inc. See adv't p. 1222.

FLOW METERS, for liquids: Facts on "Xacto;" Bowser, Inc. See adv't p. 1248.

FRACTIONATING TRAYS: Data on "Benturi, Kaskade" type; Koch Engineering Co., Inc. See adv't p. 1249.

HEAT EXCHANGER TUBES, brass and alloys: Publication B-2; The American Brass Co. See adv't p. 1121.

INSULATION, block-type: Bulletin 501; Forty-Eight Insulations, Inc. See adv't p. 1258.

INSULATION, for heated oil storage tanks: Information; Insul-Mastic Corp. of America. See adv't p. 1118.

LIQUID LEVEL, remote tank gauge receiver: Bulletin No. CP-3003; The Vapor Recovery Systems Co. See adv't p. 1206.

LIQUID LEVEL, WELDING PAD GAGES: Complete details; Jerguson Gage & Valve Co. See adv't p. 1210.

MATERIALS HANDLING: Bulletin AD-30A; The Baker-Raulang Co. See adv't p. 1131.

MIST ELIMINATORS, knitted wire mesh: Bulletin; Metal Textile Corp. See adv't p. 1108.

MIXERS, side, top, electric and air driven: Catalogs; Mixing Equipment Co., Inc. See adv't p. 1156.

OXYGEN - NITROGEN GENERATORS: Information; Air Products, Inc. See adv't p. 1193.

PAINT, selection guide: Brochure B-770; The Sherwin-Williams Co. See adv't p. 1242.

PIPE COILS, wrought iron, copper, brass, nickel, aluminum and alloys: Catalog No. 53; Crane Co. See adv't p. 1123.

PROCESS FURNACES: Bulletin S-6.2; Selas Corp. of America. See adv't p. 1132.

PROCESS, general: Information on Perco; Phillips Petroleum Co. See adv't p. 1253.

PROCESS INFORMATION: Development reports for natural gas, petroleum, petrochemical and chemical industries; Stone & Webster Engineering Corp. See adv't p. 1124.

PUMP, Micro-Feeder type: Bulletin SM-3005-2; % Proportioneers, Inc.% See adv't inside Front Cover.

RADIOACTIVE ELEMENTS: "Chart of the Isotopes"; Harshaw Scientific Division of The Harshaw Chemical Co. See adv't p. 1138.

REFRACTORY LININGS, hydraulic setting: Brochure RC-28A; Johns-Manville. See adv't p. 1218.

STEAM TRAPS, general: Catalog 751; W. H. Nicholson & Co. See adv't p. 1236

STEAM TURBINES: Data on applications; Westinghouse Electric Corp. See adv't p. 1245.

TANK CLEANING, with chemicals: Handbook; Oakite Products, Inc. See adv't p. 1250.

TANKS, calibrating: Bulletin CT-102; Warner Lewis Co. See adv't p. 1256.

TEMPERATURE INDICATOR, with 3-way adjustable mounting: Catalog; The Electric Auto-Lite Co. See adv't p. 1240.

TUBE CLEANERS: Information; The Airetool Manufacturing Co. See adv't p. 1214.

TUBING, stainless: Chart; The Carpenter Steel Co. See adv't p. 1130.

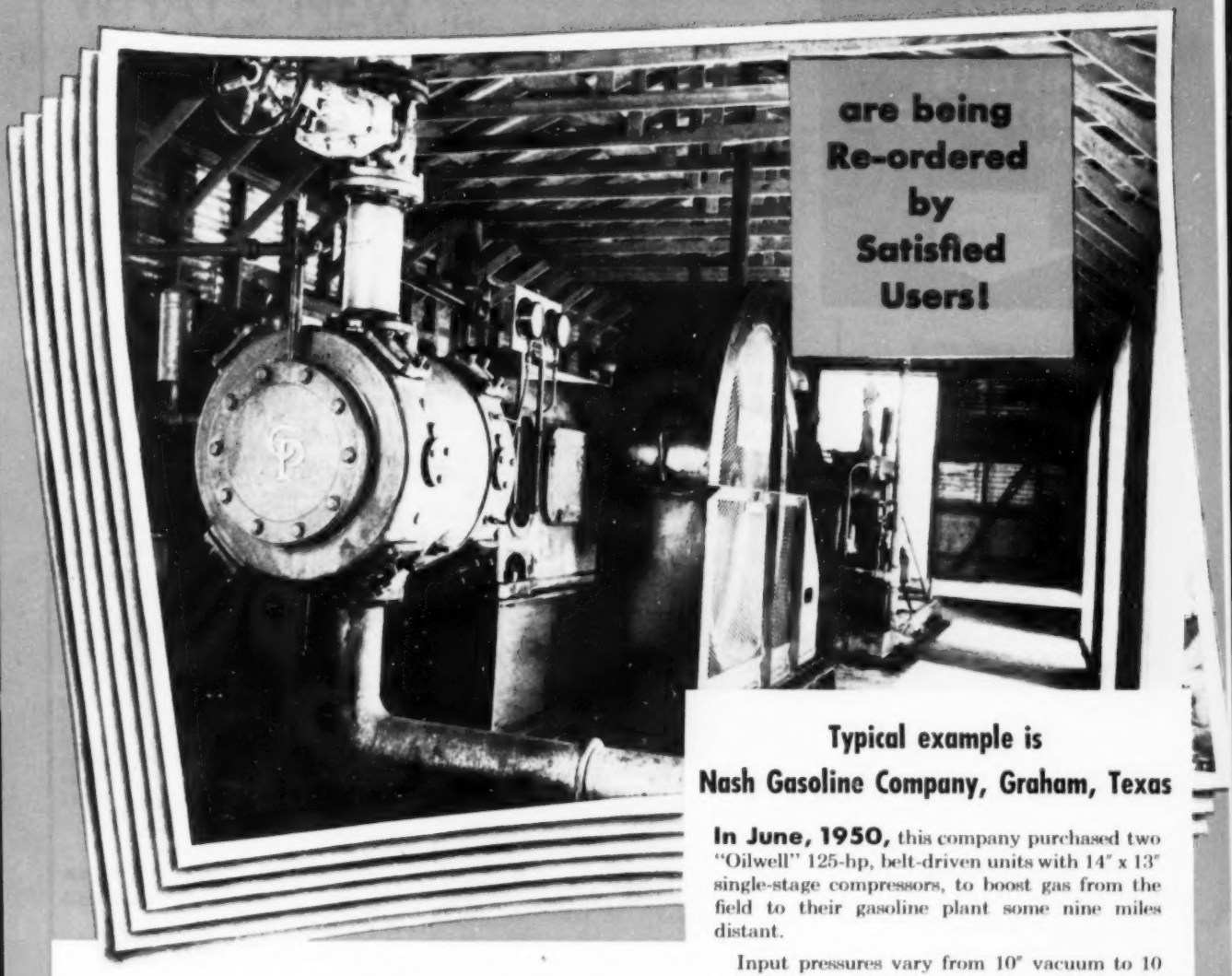
TURBINES, steam, pump drives: Full details and specifications; Dean Hill Pump Co. See adv't p. 1241.

VALVES check-tilting disc: Bulletin; The Chapman Valve Mfg. Co. See adv't p. 1247.

VALVES, control, guided stroke: Bulletin 700-2; Minneapolis Honeywell Regulator Co., See adv't p. 1127.

WATER CONDITIONING: Technical Paper No. 125; W. H. & L. D. Betz. See adv't p. 1257.

MORE and MORE "OILWELL" GAS-COMPRESSOR UNITS



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In June, 1950, this company purchased two "Oilwell" 125-hp, belt-driven units with 14" x 13" single-stage compressors, to boost gas from the field to their gasoline plant some nine miles distant.

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According to Mr. G. R. Paull, Manager of Nash Gasoline Company, the consistently good performance which the company has received from these units, together with low maintenance costs throughout the three-year period these units have been in service, was directly responsible for their decision to re-order additional "Oilwell" units for their expanding facilities.

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. . . let your "Oilwell" Representative quote on the "Oilwell" Unit that meets your requirements most economically, throughout the 20 to 300 hp range.

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Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products or services which interest him. This code letter appears in parentheses to the left of the advertiser's name.

●

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

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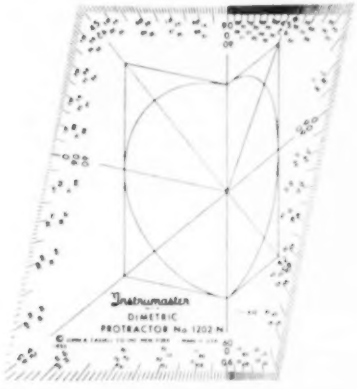
WHAT'S NEW...



Dimetric Protractor Measures Axonometric Plane Angles

. . . based on scale ratio 1:1:0.632. The protractor, to be used in conjunction with conforming dimetric equipment such as ellipse and graph paper, contains graduations both for the 1:1 plane and the two 1:0.632 planes. Each graduation covers 180° total, numbered between zero center and main reference line (usually vertical) from 0° to 90°, clockwise and counterclockwise. In addition, a second set of all numbers is provided, printed in reverse, to facilitate reading if the instrument is used in a reversed position. The tool is made of vinyl plastic. John R. Cassell Co., Inc., 110 W. 42nd St., New York 36, N. Y.

Circle No. **1** *on Reply Card*

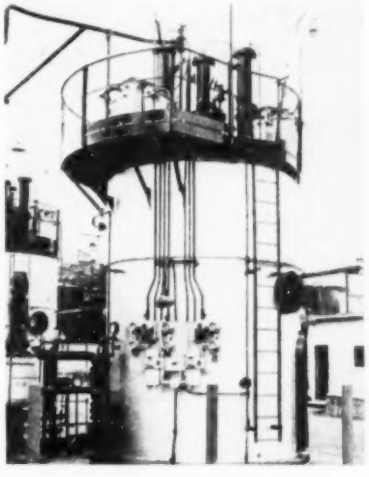
Automatic Control Systems Use Gravimetric Proportioning

. . . and attain weight accuracies as high as 0.15% at speeds of response in the order of 0.01 seconds. In these proportioning, batching and blending systems, null balance electrical and pneumatic detectors measure weights, while accessories with compatible accuracies control them. Manufacturer says application of null balance principle further speeds up plant operation, since no time is required for the scale unit to reach stable balance. Scale lag is approximately 0.01 second. Cited are several ways in which these automatic systems are being used in basic processing: (1) Continuously feeding solid materials into a chemical process at a controlled rate, the adjustable rate being direct-set on a calibrated scale; (2) Blending a liquid with a solid on the basis of weight, under conditions of varying flow, with ratio of solid and liquid adjustable; and (3) Automatically charging three reactors with weighed amounts of three different chemicals following a definite sequence, and allowing for a specified reaction time between additions. Systems are designed and engineered to individual process specifications. CDC Control Services, Inc., 400 S. Warminster Rd., Hatboro, Pa.

Circle No. **2** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.



New Lube Oil Treating Process is Automatic

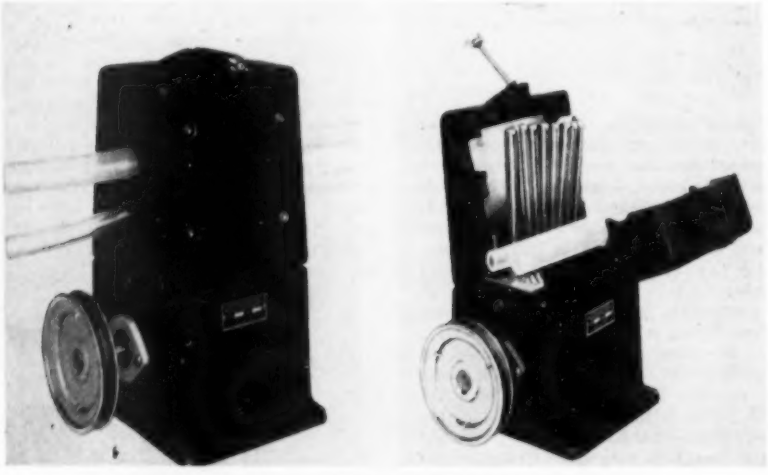
. . . replacing conventional batch agitation. The "Petreco Electric Lube Oil Treating Process" is designed for simple, continuous acid-treating of lube oils and similar stocks. Lube stock to be treated and treating acid are pumped into the mixing section and the acid-oil mixture continues on into the "Petreco" electric treater. From here, oil goes to the neutralization step, while sludge is drawn off for disposal or re-use. In commercial use, the manufacturer's treaters have a volumetric capacity of 90 b/d and are processing 2500 to 4000 b/d, depending on the type of oil treated. System is entirely closed, eliminating possibility of air pollution from escaping corrosive or noxious vapors. Oil sludge contact in the "Petreco" process is only about an hour, or even, in some cases, less. Sludge is withdrawn continuously and automatically, eliminating entrainment of lube stock. Conversely, the electric field cuts the amount of sludge in lube stock, obviating the necessity for a "water-gathering" operation on lighter lube oils. Petrolite Corp., 1390 E. Burnett St., Long Beach 6, Calif.

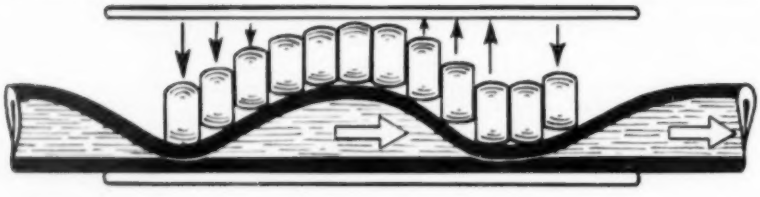
Circle No. **3** *on Reply Card*

Viscosimeter Controls and Records to Chosen Temperature

. . . without heat exchangers or other special accessories. Standard models of the temperature-compensated continuous "Viscorator" operate at stream temperatures up to 700°F., and at viscosities from 34 SSU to more than 10,000 SSF, all referred to a base temperature. The unit is preset at the factory to operate on a specific viscosity index, but other indexes may be selected in the field by adjustment of the response linkage. The instrument's base reference temperature may also be reset by an adjusting screw. Any or all of the following variables may be recorded on the apparatus: (1) Viscosity of the measured stream; (2) Viscosity corrected to a selected reference temperature; and (3) Temperature of the stream. "Viscorator" is said to correct within an accuracy of 1% of full scale for variation of 10°F. from operating temperature, and within 2% for variations of 25°F. from the operating temperature. A circular chart is utilized which conforms to ASTM standard viscosity-temperature charts for liquid petroleum products. Fischer & Porter Co., 12 Jacksonville Rd., Hatboro, Pa.

Circle No. **4** *on Reply Card*





Pump "Squeezes" Fluids Through

A series of chrome-plated steel "fingers" simulate the action of the human hand by "squeezing" fluid through flexible tubing in the new "Sigmamotor" Pump. Designed primarily to eliminate corrosion and/or contamination problems, the device permits no contact between the fluid being pumped and the working parts. Pump mechanism has a hinged top so tubing can be simply placed in position without disconnecting either end. Sigmamotor will pump liquids, gases, or solids in solution. It will handle from 45 to 250 gph. at an operating speed of 500 rpm. Different tubing sizes can be used simultaneously. Several fluids may be pumped in proportion, simultaneously and independently. Tubing recommended for use in the pump can be supplied by the manufacturer. The aluminum case is 12 in. high and has a 5-in. pulley on the side. Sigmamotor, Inc., 504 North Main St., Middleport, N. Y.

Circle No. **5** *on Reply Card*

Laboratory Mixer Combines Stirring, Tumbling Motion

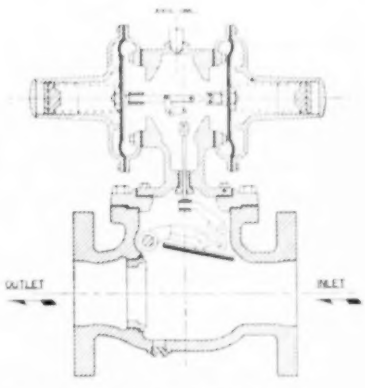
. . . incorporating the motion of human sample shaking in an electric apparatus. The unit has two arms mounted to rotate 180° out of phase with each other. Each arm has a cast-aluminum "hand" mounted at an acute angle so that when arms revolve, the sample is slid, thrown back and forth along the jar's length and moved up and down as the jar revolves. Set screws on each of the three "fingers" on each hand keep the jar in position, suction cups on each finger insure tight grip. One or both arms can be loaded, since there is no need for counterbalance. The apparatus is best suited for one-quart jars in common laboratory use. All moving parts are inside, and the 1/50 hp motor stalls if human hands accidentially enter the mechanical orbit. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Circle No. **6** *on Reply Card*

Combination Flow Detector And Liquid Level Control

. . . has no moving parts and is hermetically sealed. "Detect-A-Flo" can be used as a warning device in air-cooled equipment, as a ventilation control and other similar applications where a particular flow rate must be maintained, or as a liquid level detector or controller. In the latter usage, the unit is said to respond to level changes of less than 0.1 in., and viscous fluids are said to have little or no effect on operation. The apparatus can be set to respond to any mass rate flow of air in the approximate range 1 000 to 5,000 lb./hr./sq. ft., corresponding to less than 4 ft. to more than 180/ft./sec. for flows of standard air. The unit does not depend on pressure drop for operation, being based on the principle that the amount of heat conducted away from a constant heat source varies with the flow of air moving past that surface. One leg of the unit is continuously heated by a small internal heater. As flow rate drops, the heated leg expands because less heat is carried away. The resulting expansion is transmitted through lever action to a strut-and-electrical-contact assembly in the other leg, causing a relaxation in the struts and moving the contacts apart, breaking the circuit. Operating temperature range is −65° F. to 175° F., and the unit retains its accuracy in either a constant or changing ambient temperature. Fenwal, Inc., Ashland, Mass.

Circle No. **7** *on Reply Card*



Automatic Shut-Off Valves Close Gas or Fluid Lines

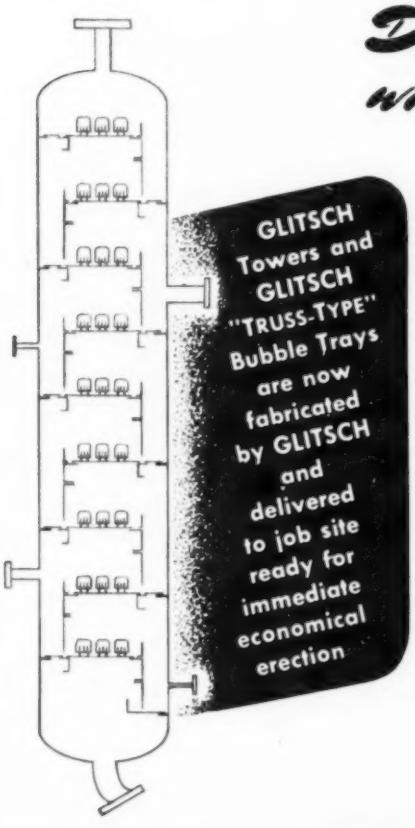
. . . with either increase or decrease in pressure, or both, depending on the model selected. "Security" valves can be installed either upstream or downstream in relation to the regulator, with or without static control, for either high or low pressure application. Illustrated is Model "IDPS-L", which closes on either increase or decrease of pressure, with static line control for low pressure application. The units are available in cast iron or steel, and can be placed in existing pipe lines, it is said, with negligible pressure drop. Security Valve Corp., P. O. Box 1551, Los Angeles, Calif.

Circle No. **8** *on Reply Card*

279 designs

Glitsch Has Dies for 279 Cap and Riser Assemblies for Specific Requirements

Existing dies of 279 different cap and riser designs are available for process recommendations as well as data on the various ratios of related areas. Customers' engineering staffs have found GLITSCH'S experience relative to this wide range of assemblies an added value in planning stages. Practical ideas for improvements in the constantly changing petroleum refining and chemical processing industries are a part of GLITSCH service in their world-wide operations.



GLITSCH Towers and GLITSCH "TRUSS-TYPE" Bubble Trays are now fabricated by GLITSCH and delivered to job site ready for immediate economical erection

Design your process requirements with complete freedom of design

The GLITSCH design offers its outstanding, flexible features and mechanical supporting structure to the refining and chemical processing industries. The process engineer has complete freedom to design accurately the most efficient bubble tray for each of his process problems.

GLITSCH trays are doing a top notch job in all types of fractionation and distillation equipment such as vacuum, crude, light ends and petrochemical units. GLITSCH *"TRUSS-TYPE"* light weight bubble trays are custom-built from the corrosion resistant materials best suited to the individual needs of each fractionation job.

Glitsch "TRUSS-TYPE" Bubble Trays, Towers and other Petroleum Refinery, Chemical and Industrial Equipment

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NICHOLSON W. O. TRAPS

Cannot Leak Live Steam

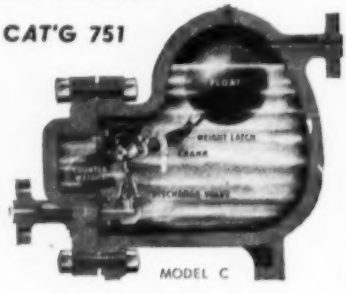
Even though re-evaporation completely dries up its body, a Nicholson weight-operated trap will not leak live steam. Widely used for steam purifiers, super-heated steam lines, headers, separators, heaters, etc.

DRAIN WATER, GASOLINE, OIL

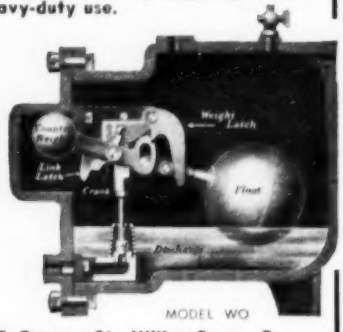
Nicholson W. O. traps also have many applications in natural gas industry: drain gasoline from scrubber head of booster and gas lift compressors; gasoline, oil or moisture from gas well separators, accumulators, after-absorbers, etc; package natural gasoline plants; gas lines.

4 TYPES—press. to 200, 500, 650, 1500 lbs.; for every large capacity, heavy-duty use.

CAT'G 751



MODEL C



MODEL WO

215 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

"FIRST in the FIELD"

for

Efficient FILTERING

RONNINGEN

New Type

FLUID FILTER

For PROCESS WATER . . .
GASOLINE . . . OILS . . .
HYDRAULIC FLUIDS . . .
CHEMICAL LIQUIDS

Capacities: 5-1500 G.P.M.
Mesh in stock:
60-100-200 Monel metal
Pressures: to 150 P.S.I.

Particles large or small,
We FILTER them all

STRAIN AGAIN with RONNINGEN

QUICK COUPLING — Quick Disconnect, Quick Connect — no tools
QUICK BLOW-OFF for cleaning

NON SHORT-CIRCUITING—Ends are welded—No by-passing

Read all about it in our BULLETIN No. 1152-P

RONNINGEN MANUFACTURING CO.

Quick Coupling *FLUID FILTERS* Non Short-Circuiting

Vicksburg, Michigan — Phone 5161

What's New!

Plastic-Rubber Film Can Be Electronically Sealed

. . . to itself, so that no cementing or taping of seams is required. "Vulcafilm", combining the properties of plastic and synthetic rubber, was recently used by the tank manufacturer to make an oil tank diaphragm. While in this particular instance the material was unsupported by fabric, it can be combined with many types of fabric reinforcement. The compound itself can be varied to obtain resistance to oil, gasoline, sunlight, heat, cold, abrasion and acids. As used for oil tank diaphragms, "Vulcafilm" has acted to eliminate evaporation from stored petroleum products. In one design the diaphragm rises and falls with liquid surface, while in another the diaphragm is suspended in space by the slight pressure of expanding vapors. In tanks containing sour crude, the material is said to protect tank walls and top against corrosive sulfuric acid fumes. B. F. Goodrich Co., Akron, Ohio.

Circle No. **9** *on Reply Card*

Thermocouple Head Is Cadmium Plated Malleable Iron

. . . to resist corrosion. "Serv-Rite" is compactly designed and contains a new style friction-lock cap which can be tightened or removed by a quarter turn. Within the cap is an asbestos gasket to assure a dirt- and moisture-tight head. Connector block is constructed of heat resistant material which withstands temperatures up to 900° F. in continuous service. Design permits easy withdrawal of complete element including connector block. Choice of ½ in., ¾ in. and 1 in. IPS protecting tube is available. Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

Circle No. **10** *on Reply Card*

the first step

TO SOLVE YOUR HIGH-TEMPERATURE PROBLEM

HIGH TEMPERATURE WORK SHEET
A simplified form to describe your material problem for study and suggestions.
THE INTERNATIONAL NICKEL COMPANY, INC.
DEVELOPMENT and RESEARCH DIVISION
67 Wall Street - New York 5, N. Y.

This coupon will bring you our High Temperature Work Sheet so that you can turn your troubles over to Inco's High Temperature Engineering Service for analysis and suggestions. No obligation whatsoever, of course, whether they recommend an Inco Nickel Alloy or some other material as the most practical answer to your particular problem.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.
Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name_____

Company_____

Address_____

City_____ State_____

(To obtain more data on advertised products see page 1232)

It's a Matter of Record

It's a Matter of Record

REFINING . . . NATURAL GASOLINE AND PETROCHEMICAL PLANTS OPERATE ON A 24-HOUR . . . SEVEN-DAY-A-WEEK BASIS. WHEN YOU NEED A PUMP FOR YOUR PLANT YOU DON'T RUSH OUT WITH A WAD OF BILLS AND BUY A PUMP . . .

It's a Matter of Record

YOU SPECIFY Precision Built Pumps by PACIFIC PUMPS INC. because pumps for your exacting service are a considered purchase and

It's a Matter of Record

that customers say . . . "We believe Pacific is just about the finest group of pumps we know anything about."

It's a Matter of Record

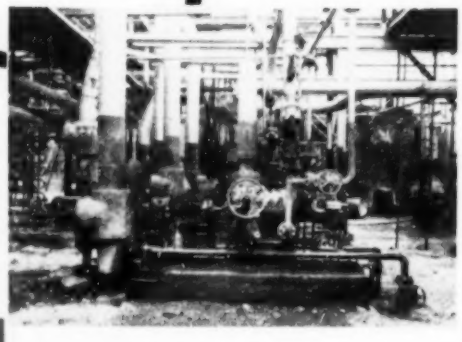
That in the continuous process industries . . . shutdowns are costly . . . maintenance is a big problem . . . availability of parts and service facilities are important.

It's a Matter of Record

That customers say . . . "Pacific Pumps Inc. is large enough to stand behind the product they manufacture and small enough to give each order individual attention."

It's a Matter of Record

The excellent performance of the two stream-turbine driven four-stage pumps installed in 1939 to pump light hydrocarbons of .465 sp. gr. operating at 3400 R.P.M. In 1942 the speed was increased to 3900 R.P.M. From 1939 to 1950—time on stream 82 + % . . . pump parts refinished 0 . . . pump parts replaced 0. Third unit installed in 1947 to operate at 4000-4200 R.P.M.



PACIFIC *Precision Built* PUMPS

Pacific Pumps inc.

ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York

Offices in All Principal Cities

CP-6

Cancer strikes 1 in 5

Strike back

Give

Your gifts to the American Cancer Society help guard those you love.

Your dollars support research in a hundred laboratories and universities . . . spread life-saving information . . . ease pain and suffering . . . provide facilities for treatment and care of cancer patients.

It is a sobering fact that cancer may strike anyone tomorrow: strike back today with a gift to the American Cancer Society. You may mail it, simply addressed CANCER, c/o your local post office.

American Cancer Society

Better Valves–Year After Year

Because throughout more than a hundred years Powell Engineers have never been willing to "let well enough alone," the Powell Line of Valves has been continually improved and expanded to satisfy every new demand of industry.

That is why there is a greater variety of Powell Valves in service today than of any other make.

Fig. 376 — 200-pound Bronze Gate Valve with screwed ends, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze disc.

The Wm. Powell Company
Cincinnati 22, Ohio

Fig. 3003 — 300-pound Cast Steel O. S. & Y. Gate Valve.

Fig. 2342—Stainless Steel Swing Check Valve for 150 pounds W.P. at 500F. Also made for 300 and 600 pounds W.P. at 800F. Available in other corrosion-resisting metals and alloys. Also furnished with screwed ends.

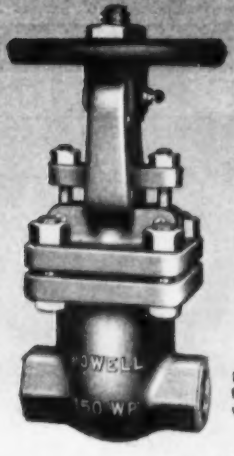
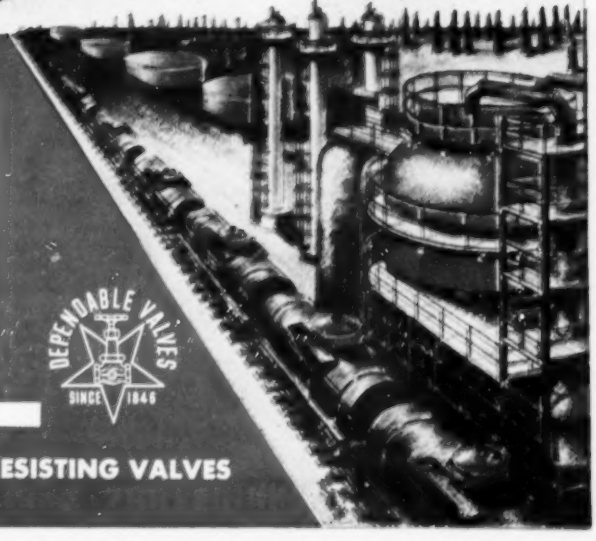


Fig. 2490 — Stainless Steel O. S. & Y. Gate Valve for 150 pounds W. P. at 500 F. Can be furnished with solid or split wedge and with flanged ends.

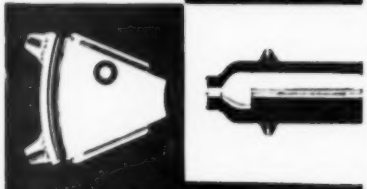
POWELL

DEPENDABLE VALVES SINCE 1846

BRONZE, IRON, STEEL AND CORROSION RESISTING VALVES



FOR VISCOUS FLUIDS...
WELDING-JACKETED FITTINGS



ALSO AVAILABLE -
SCREWED & FLANGED
FITTINGS & PIPE

Red Jacket Company, Inc.
MANUFACTURERS OF JACKETED FITTINGS AND JACKETED PIPE
INVESTMENT BUILDING
PITTSBURGH 22, PENNSYLVANIA

from SHAFT POSITION
to DIGITAL representation with 0.09-degree accuracy

THE ERA SHAFT MONITOR

ERA SHAFT MONITOR shaft position indicators detect angular position of a rotating shaft and convert the result to digital representation.

ACCURACIES of 0.09-degree are practical. Measurements may be displayed remotely in digital form or transferred to magnetic tape, punched tape, punched cards or used for control.

For more information on ERA Shaft Monitor Analog-to-Digital Converter, write on your business letterhead to:

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For Eye-Level Readings...

AUTO-LITE

...TEMPERATURE INDICATION

Auto-Lite offers many thermometer styles, permitting plant-wide temperature observation at low cost. Standard temperature ranges from minus 60°F to plus 750°F. Send for latest catalog showing various types.

Model F-1 temperature indicator—Rigid stem or capillary tubing for EYE-LEVEL remote reading. Priced from $22.

THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
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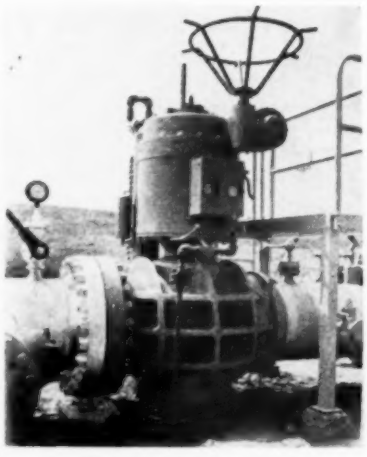
TEMPERATURE INDICATORS & RECORDERS

What's New!



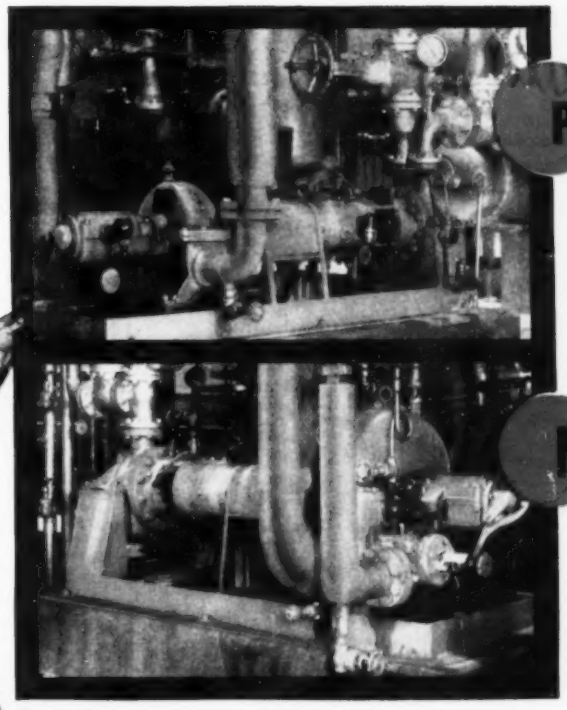
Valve Operator Will Open Or Close 24-in. Plug

. . . in two seconds without mechanical shock. The "Shafer" plug valve operator, illustrated above, is one of several at a gas compressor station interlocked for quick closure when actuated from one of three emergency remote manual control stations. The units can be installed on existing 1½ in. to 30 in. plug valves, and can be powered with gas, air or liquid at pressures from 60 to 1,000 psi. The single moving part applies torque directly on and about the plug valve stem like a two-handled wrench. It is available for manual, cyclic or automatic remote control, with pneumatic, hydraulic or electric initiation. Shafer Valve Co., Inc., Bradshaw & Co., representatives, 530 4th Ave., Pittsburgh 19, Pa.

Circle No. **11** *on Reply Card*

Oscillograph Records 50 Active Data Traces

. . . on 12-in paper or film, 250 ft. long, at speeds from 0.10-in. to 100-in. per second. The Type 5-119 Recording Oscillograph contains automatic safety circuits to give immediate warning should some failure cause record loss. Reserve lamps begin operation in the event of main record lamp failure. Circuits are provided to check condition of the main and reserve lamps, timing lamp, heater operation, and paper supply. Additional



POWER!

For Your Small Jobs

Installed in a large southern refinery, this Dean Hill Type DH Steam Turbine efficiently provides all the H.P. needed for driving centrifugal process equipment

MORE POWER!

For Your Big Jobs

1,000 H.P. is available for this process pumping operation (same plant as above). Dean Hill is on the job with this powerful steam turbine.

MOST POWER!

For Your Money With DEAN HILL Turbines

Small and large, Dean Hill Turbines are built to give all the power you need, at less expense. Specifically designed for operation at medium steam pressure. Since they are the single stage, double impact type, low steam consumption is a tremendous economy feature. Most key DH Turbine parts are interchangeable in all sizes of DH Turbines. Write today for full details and specifications.

DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1895

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NEW! handy guide on Refinery Painting

Puzzled over painting problems? Here's a new guide that takes the guesswork out of refinery painting. In 12 easy-to-read pages, with painting recommendations in handy check chart form, it tells at a glance the right paint to use on each type of interior or exterior surface—for surfaces exposed to various temperatures and operating conditions.

Included are suggestions on surface preparation and helpful painting hints.

Ask for your copy . . . write for Brochure B-770. The Sherwin-Williams Co., Petroleum Division, Cleveland 1, Ohio.

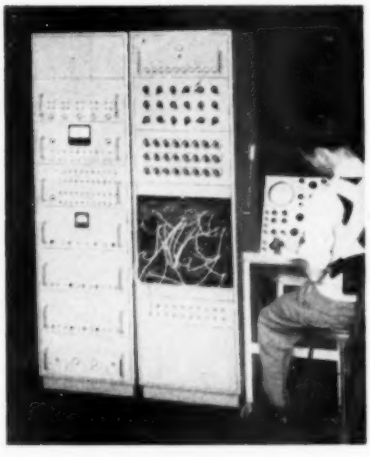
SHERWIN-WILLIAMS
PETROLEUM FINISHES

COVER THE EARTH

What's New!

test circuits check the warning systems. Frequencies from 0 to 3000 cps may be recorded by installing the manufacturer's precision galvanometers. Record speeds are changed without tools through interchangeable gears, accessible when the magazine is removed. A jump switch increases record speed ten times without stopping the unit, spreading complex wave forms to allow quicker, easier and more detailed interpretation of data. Timing lines are adjustable to full record width or 1-in. borders at intervals of either 0.01 or 0.10 seconds between lines. All controls and indicators are located on the front panel. The unit stands 13¼-in. high, 15½ in. wide by 27-11/16 in. long and weighs 145 lbs. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

Circle No. **12** *on Reply Card*



Analog Computer Simulates Physical Systems Electronically

. . . operating as an equation solver, a system analyzer or a design instrument. Either the empirical or theoretical formula for a system under study may be set up on the "EASE" computer, the problem then being solved by varying coefficient potentiometers. The unit operates in real time, using actual physical hardware in a closed loop, or in fractions of real time. To extend the capacity of the apparatus to solve more complex problems, components may be added by inserting them into the rack and plugging into the receptacle unit. Users need only purchase the facilities which they initially require, with assurance that future requirements won't make those facilities obsolete. The unit stands in two or three racks approximately 6 ft. 4 in. high, 20¾ in. wide and 15 in. deep. Beckman Instruments, Inc., South Pasadena 1, Calif.

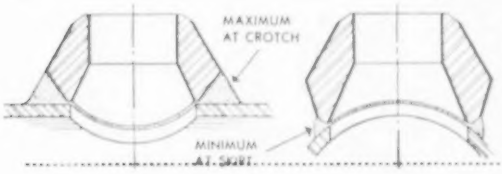
Circle No. **13** *on Reply Card*

WELDOLET WELDING FITTINGS
MEAN PERMANENT PIPING
... PERMANENT SAVINGS

Here's Why

Every fitting is shaped to fit the pipe and is self-aligning.

The template is the inside of the fitting. The hole in the run-pipe can be cut out either before or after the fitting is installed.



Welded as indicated—to fill in 50° bevel at crotch, blending into 35° bevel at skirt—full reinforcement is accomplished.

The outlet is machine-beveled for quick, easy butt-welding of the branch pipe—shop or field fabrication.

Here's How

1. The WeldOlet is raised off the run pipe to establish proper weld gap, as required by Code for all types of branch connections. This is accomplished by placing spacers, e.g. welding rods, under the fitting.
2. The base joint is tack welded, preferably at four points, each half way between the crotch and skirt sections of the fitting. The spacers are then removed.
3. The stringer bead—or beads—is applied completely around the base of the fitting. The established weld gap assures full penetration.
4. Additional passes are applied as necessary to fill in the tapered base bevel of the fitting. The intermediate passes should not be continuous. Re-inforcing welds should be made at the crotch bevel area at each side of the fitting only. A continuous cover bead should be added, filling the bevel at the base of the fitting at the crotch and skirt sections.

TO COMPLETELY SAFEGUARD AGAINST:

- high pressures
- high temperatures
- internal corrosion
- external stresses

TO PROVIDE:

- improved fluid flow
- trouble-free and permanent piping systems

TO ACCOMPLISH ALL THESE THINGS IN THE MOST ECONOMICAL MANNER . . . SPECIFY AND USE

BONNEY WELDOLET WELDING FITTINGS

DISTRIBUTORS IN PRINCIPAL CITIES

FOR COMPLETE ENGINEERING DATA WRITE FOR YOUR BONNEY W-3 WELDOLET CATALOG.

WELDING FITTINGS DIVISION

BONNEY FORGE & TOOL WORKS

ENG. DEPT., 368 GREEN STREET
ALLENTOWN, PENNSYLVANIA

(To obtain more data on advertised products see page 1232)

NATIONAL AER-O-FOAM

GIVES TRIPLE-GUARDED PROTECTION

CUSTOM-DESIGNED
To Your Exact Needs

Using the largest, most varied line of foam products and devices, National custom-designs your foam fire protection system to fit your exact hazards, for top efficiency and economy.

QUALITY-CONTROLLED
To Give Faster-Acting Foam

National makes all its foam liquid in its own plant . . . quality-controls it at every step of manufacture to provide an instantaneous, tough, gas-tight foam blanket.

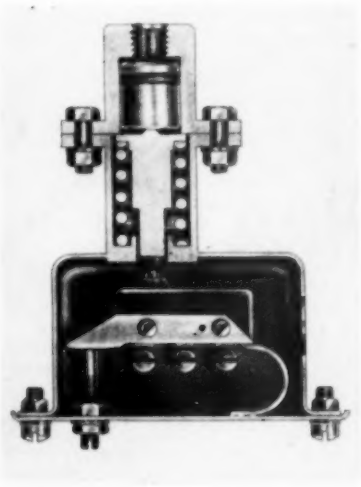
FIRE-TESTED
For Proven Performance

National fire-tests every batch of foam it produces and all its types of foam devices . . . checks their performance on actual flammable liquid fire, for full dependability in your plant.

WRITE TODAY for your copy of the fact-filled booklet, "Foam and How to Use It."

NATIONAL
FOAM SYSTEM INCORPORATED
WEST CHESTER, PENNA.
Headquarters for Foam Fire Protection

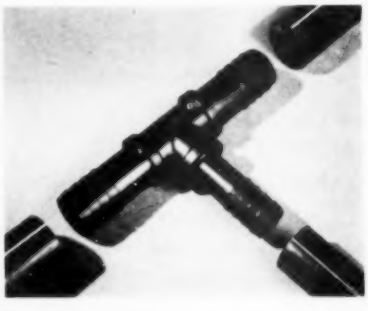
What's New!



Pressure Switch Has An Adjustable Sensing Range

. . . from 15 to 3000 psi, and actuates an electrical circuit on increasing or decreasing pressure. The unit's piston-type pressure sensing element is not subject to fatigue, and is best suited, it is claimed, for applications where millions of cycles are expected of the switch. The basic body kit may be converted to changing service requirements by means of interchangeable fitting kits. The mounting bracket fits around the neck of the unit and may be rotated a full 360° as well as moved up and down. Switch may be mounted in any position and is not sensitive to vibration or line surges. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

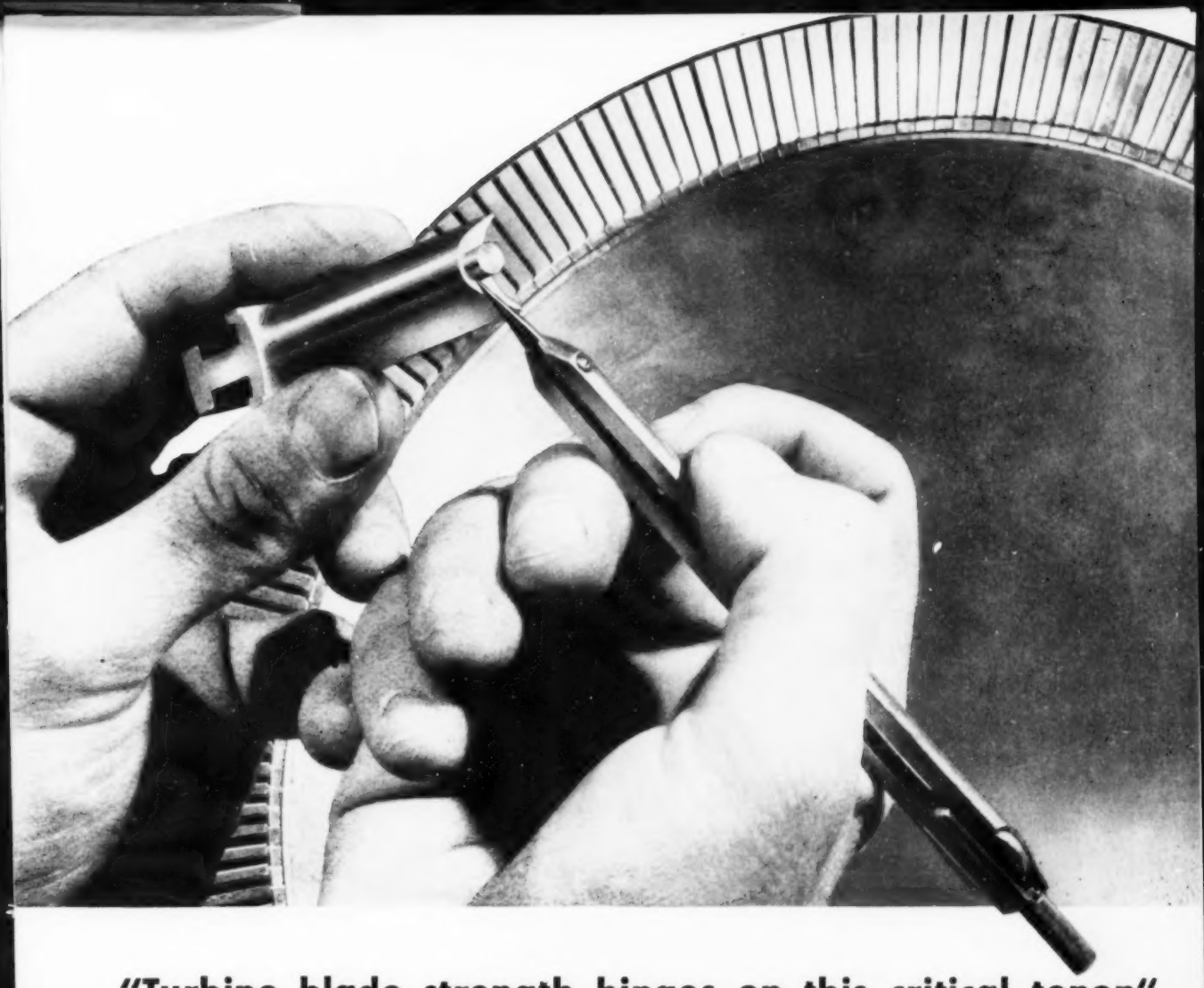
Circle No. **14** *on Reply Card*



Insert Tee Fitting For Plastic Pipe Has Reduced Side Outlet

. . . one standard pipe size smaller than the run. The new fitting, available in run sizes up to 2 in., is said to facilitate installation of step-down lateral pipe construction. After the unit is inserted in the pipe, stainless steel clamps are tightened over pipe and fitting to make the joint leakproof. The tee fitting is molded from

(*To obtain more data on advertised products see page* 1232)



"Turbine blade strength hinges on this critical tenon"

Westinghouse research proved that a single rough notch or "square corner" at this critical point reduces blade strength by 50%! All blades vibrate at their natural frequency. The amplitude of the vibrations must be carefully controlled. Any notch or "stress concentration" reduces allowable amplitude—reduces blade strength.

Fifty years ago Westinghouse recognized the importance of vibratory stress considerations, and today has an unequaled wealth of data upon which each new design is built. In these blade tenons, for example, *every* tenon fillet is final-machined with a special tool to achieve a precisely contoured fillet. Backing this is careful control of amplitude throughout the full range of operating speeds. Result—sound, stable blading with inherent extra strength.

Every Westinghouse turbine user has the advantage of this combination of design excellence and manufacturing skill. It is responsible for the many features in all Westinghouse General-Purpose Turbines.

For full information on these advanced turbines—and sound advice on your steam applications call your Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-50562

Type E-220 General-Purpose Turbine

This high-speed, multi-stage turbine, 500 hp to 5000 hp, is ideal for drives requiring speeds up to 10,500 rpm. It incorporates all the features and considerations of the rugged, reliable, single-stage Type E.

Turbines for every industrial use

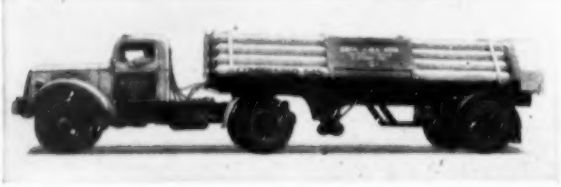
YOU CAN BE **SURE**... IF IT'S

Westinghouse

Why?—Because there's no rolling, lifting or sliding heavy cylinders when high pressure gases are delivered the Taylor-Wharton way.

In fact, there's no exchange problem at all. The first to appreciate this are customers, shipping and receiving personnel and drivers. Each T-W Gas Transport replaces 200-400 conventional high pressure cylinders, and can be delivered as a unit to remain right at the user's plant. When exhausted, the transport is returned to producing point for re-load.

Rugged design, careful workmanship plus our vast experience in producing seamless steel gas cylinders combine to make Taylor-Wharton Gas Transports the safest possible. Gross weight is 28,000 lbs., including 30 tubes mounted on single axle with 2-speed landing gear and air brakes. Write for details.



Units now in use carrying:

- Oxygen
- Nitrogen
- Helium
- Boron Trifluoride
- Hydrogen

TAYLOR-WHARTON GAS TRANSPORTS a product of

THE TAYLOR-WHARTON IRON & STEEL CO.

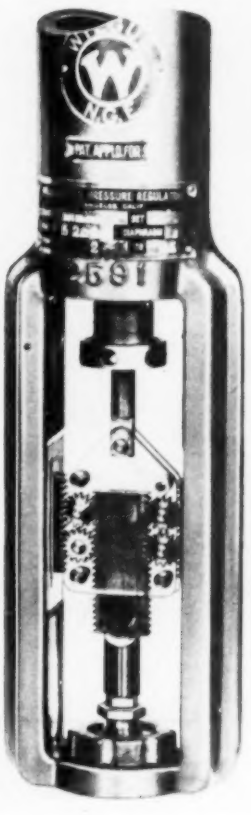
CINCINNATI 12, OHIO

Also Manufacturers of: Manganese Steel Castings, Alloy and Carbon Steel Castings, Special Trackwork, Gas Cylinders.

What's New!

a single piece of thermoplastic material, and is claimed by the manufacturer to be proof against rot, rust and electrolytic corrosion. Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio.

Circle No. **15** *on Reply Card*



Diaphragm Valve Accessory Doubles Stroke at Inner Valve

. . . giving closer regulation of fluid flow. "Magna-Stroke" is essentially a gear train working at a ratio of 2:1. It allows fluids or gas vapors to be maintained at a desired pressure with half the variation in valve action. Valves energized by pilot instruments responding to pressure or temperature changes in the system are said to respond twice as fast, only half as much change being needed at the diaphragm to give the same effect at the inner regulating valve. Since less pressure change is needed with the unit, a smaller diaphragm can be used. When reversed, the effect achieved at the inner valve is double that of the power. Thus in instances where high pressure is involved, as when used with a single port valve, a positive shut-off is obtained. Natural Gas Equipment, Inc., 190 E. Glenarm St., Pasadena 2, Calif.

Circle No. **16** *on Reply Card*

Cushioned

to a drop-tight seat...

... that's why these unique

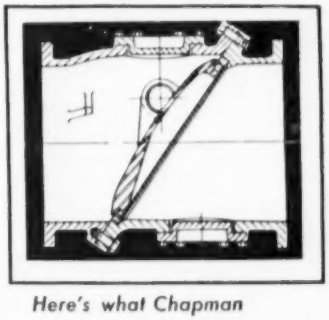
CHAPMAN

***Tilting Disc* CHECK VALVES**

cut head-loss to lowest levels

The Chapman Valve Mfg. Co.

INDIAN ORCHARD, MASSACHUSETTS

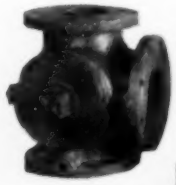


Here's what Chapman means by "Cushioning:"

This specially designed, "air-foil" disc balances perfectly in open position . . . then drops easily to closed position (cushioned by the flow). No jarring or slamming, in usual pipe-layouts. Write for bulletin.

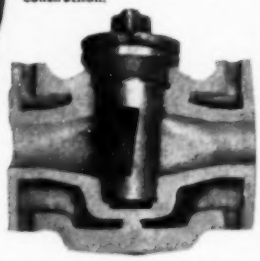
CHAPMAN (TILTING DISC) **CHECK VALVES**

(To obtain more data on advertised products see page 1232)



At left: Jacketed 3-Way Plug Cock.

Below: Cutaway section of Jacketed Cock, showing packing gland construction.



Jacketed Pipe, Pumps, Valves and Fittings . . .

Jacketed Meter, with set-back register, for measuring viscous liquids.

for maintaining uniform temperatures (hot or cold) in process pipes

Regardless of whether the material is being heated or cooled in the processing, and what heating or cooling medium is being used, H & B jacketed fittings are available for all applications. Steam, hot water or hot oil may be used for heating, cold water or brine for cooling.

H & B can save you money on your jacketed pipe and fitting requirements because we buy all standard size pipe from the mill in carload lots, make our own special flanges in quantities, and are tooled up for making jacketed equipment at lowest possible price. Write for Bulletin J-50.

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XACTO METERS

XACTO is the meter that's changing liquid-handling habits in every industry where liquid measure and control have been a problem.

XACTO safely handles over 600 different liquids in processing, blending, packaging and many other batching or continuous operations.

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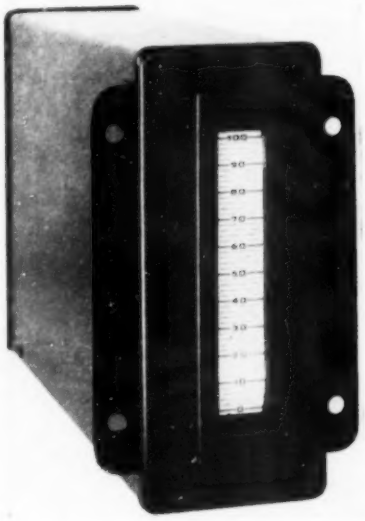
What's New!



Ribbon-Type Indicator For Graphic Panels

. . . is especially suited to give continuous indication of valve position or variables such as liquid level. The indicator scale measures only ¾ in. x 4¼ in., and all component parts are mounted on a removable chassis and protected by a housing secured to back of the panel. The Model 50 Consotrol Indicator receives pneumatic measurements from a transmitter located at the process. This force is applied to a receiver bellows, which, through a lever and stainless steel tape arrangement, rotates two lightweight drums. A brightly colored Nylon tape, wound on the drums, is drawn behind a glass pane on which scale graduations are printed, thus making internal illumination unnecessary. Both single and dual indicating scales are available, and they can be adjusted for direct or reverse response to measurement. Alarm contacts of the mercury switch type are provided optionally. The Foxboro Co., Foxboro, Mass.

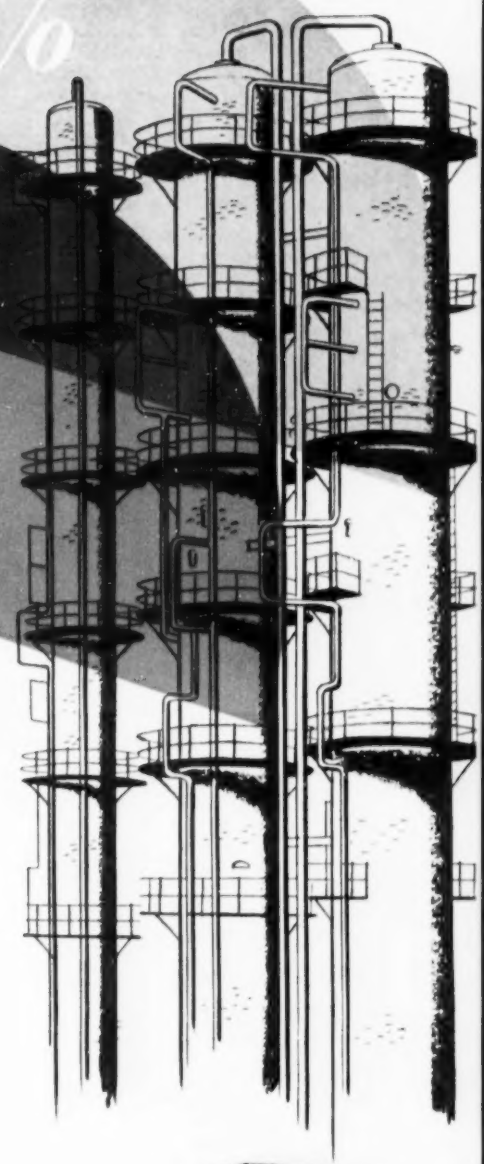
Circle No. **17** *on Reply Card*

Differential Controller Gives Additional Flow Measurement

. . . at orifice meter measuring stations where a wide variation of flow conditions are likely to be encountered. The unit automatically turns another measuring unit into the line when needed, and shuts it off when the fluid load drops below a pre-set minimum. The differential controller is mounted in the orifice meter case, offering a compact unit of strong construction. The orifice meter which actuates the control mechanism also serves as the primary measuring unit. A cylinder-operated Nordstrom valve is used to give positive shut-off. As no additional motor valve is required,

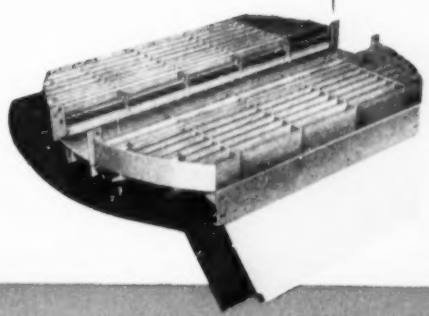
(*To obtain more data on advertised products see page* 1232)

You can save 30% to 50% of your tower costs



Design Factors	Bubble Trays	"Benturi" Kaskades
Low vapor thruput	+	–
High vapor thruput	–	+
Low liquid thruput	+	–
High liquid thruput	–	+
Low pressure drop	–	+
High pressure drop	+	–
High pressure towers	–	+
Low pressure towers	+	+
Alloy or alloy-clad towers	–	++
Shop fabricated towers	–	+
Field fabricated towers	–	++

Check your requirements on this simple chart. While any one of the "plus" features justify the economy of Koch "Benturi" Kaskade trays, a combination of these conditions provides a "bonanza" to the operator. We'll be glad to give you data on "Benturi" installations to fit your requirements. No obligation.



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Myers-Bagwell Co.
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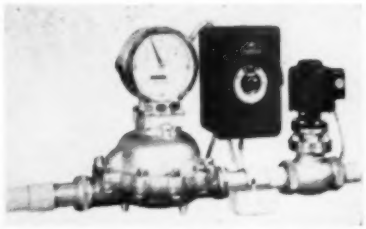
British Associates
Messrs. A. F. Craig & Co.,
Paisley, Scotland

the amount of equipment is reduced. A minimum of 10 psi. is required to actuate the control unit and 50 psi. to operate the valve cylinder. Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

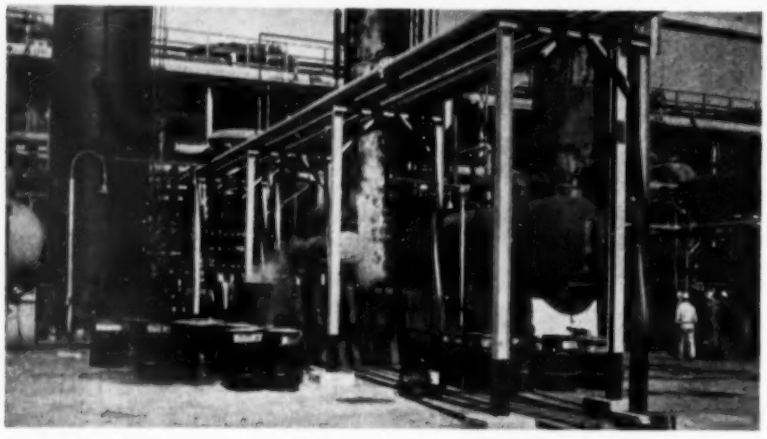
Circle No. **18** *on Reply Card*

Liquid Metering System Has Push-Button Control

. . . eliminating manual resetting before each run. "Niagara Electrivolume" is built to measure cold and hot-water base liquids, viscous and non-viscous oils and many corrosive chemicals. In operation, an electric impulse is generated in a power circuit upon delivery of each unit of liquid. Impulses are transmitted to an impulse counter which accumulates them up to the preset number. Upon reaching this point, a solenoid valve in the liquid line closes, and the counter recycles itself back to zero for the next run. Manufacturer says unit saves time and gives greater accuracy. An alternate use for the meter is to actuate an electrically-driven integrator located away from the meter. Buffalo Meter Co., 2956-P, Main St., Buffalo 14, N. Y.



Circle No. **19** *on Reply Card*



Turnaround shortened one day by new cleaning method

Comparative report shows Oakite Compound No. 88 cuts cleaning time by 20%

This large refinery felt it was taking too much time to clean equipment during turnaround. To compare jobs, time, and costs, Engineering decided to test two chemical methods, one of which involved Oakite Compound No. 88 and the Oakite Man's knowledge of refinery cleaning problems.

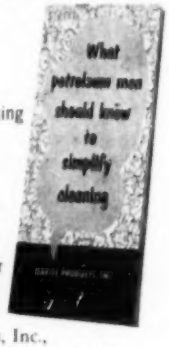
The engineer's report speaks for itself: "...no gas disposal problem...no chance of running tower over...no delay...cheaper from chemical consumption standpoint...Oakite procedure should cut overall cleaning time by 20%...recovery turnaround would be *at* least one day shorter."

Proving that – in industrial cleaning it always pays to consult Oakite.

Call your Oakite Technical Service Representative. His experience is yours to draw on. He'll study your cleaning problem, suggest and demonstrate the best material and method. He'll keep checking back to see that you get top quality cleaning at low cost. Call him today!

FREE HANDBOOK—
full of facts on

Drum reconditioning
Descaling
Cleaning tanks
Salvage cleaning
Paint stripping
Cleaning tank car interiors



Write Oakite Products, Inc.,
50D Rector St., New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
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MATERIALS • METHODS • SERVICE
Technical Service Representatives in Principal Cities of U. S. and Canada

petroleum service division

Trade Literature

Organic Reaction Catalyst

. . . benzyltrimethylammonium chloride, marketed in a 60-62% aqueous solution; specifications, physical properties and uses described in *Technical Data Sheet* 17; shipping weights are also listed. Commercial Solvents Corp., 260 Madison Ave., New York 16, N. Y.

Circle No. **20** *on Reply Card*

Insulation Heat Loss Estimate

. . . sheet, used in preparing analyses of thermal insulation for heated industrial equipment; step-by-step instruction for recording survey data for each type of heated surface, with Btu and dollar savings provided by different types of insulation; in 4-page pamphlet. Industrial Mineral Fiber Institute, 441 Lexington Ave., New York, N. Y.

Circle No. **21** *on Reply Card*

Automatic Graph Plotting

. . . to create graphs from punched cards; 8-page booklet tells how method can be used to obtain line, point and bar graphs, yielding quick evaluation of performance data. International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.

Circle No. **22** *on Reply Card*

Regulating Feeders

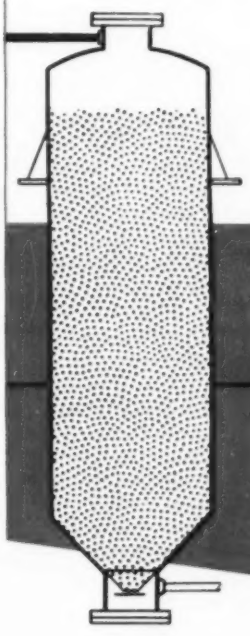
. . . for solid materials discussed in 12-page *Bulletin* 33-*E;* covering design details, capacities, dimensions and application of a wide variety of units. Hardinge Co., Inc., York, Pa.

Circle No. **23** *on Reply Card*

Welded Floats

. . . for level instruments, in stainless, Monel and chrome-plated steel, in spherical, elliptical and cylindrical shapes; weights, buoyancies, collapsing pressures and prices listed in 8-page *Bulletin* 753. W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa.

Circle No. **24** *on Reply Card*



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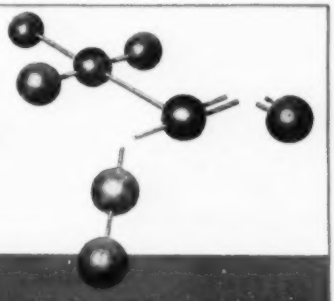

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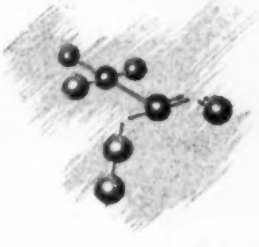

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for Any Operating Condition
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Minimum Pressure Drop
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of any metal or rubber-lined in sizes to 120"

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What's New!

Corrosion Resistant Alloys

. . . described in seven separate *Data Sheets* which outline corrosive media which the manufacturer's nickel- and iron-base alloys will resist, as well as structural properties of several specific tools. Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.

Circle No. **25** *on Reply Card*

Instruments for Waste Disposal

. . . and water treatment; 26-page Bulletin 7302 is a guide for organizing engineering thoughts on treatment procedures; profusely illustrated with photos and flow diagrams; with literature references. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **26** *on Reply Card*

Vertical Compressor

. . . designed for use applications where compressed air must be free of lubricating oil; 8-page Bulletin A-44 gives section drawings and dimensions on manufacturer's line of non-lubricated compressors from 172 to 8800 CFM, 25 to 600 hp are given. Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa.

Circle No. **27** *on Reply Card*

Pipe Branch Joints

. . . for threaded or welded connections; comprehensive description of manufacturer's line of fittings including specifications on each item, installation instructions and technical data with many illustrations; in 34-page *Catalog* W-3 (Revised). Bonney Forge & Tool Works, Allentown, Pa.

Circle No. **28** *on Reply Card*

Hot Metal Gray Coating

. . . for stacks, flues and other surfaces which are heated in the 600°-1200° F. range; a brief discussion on what the product is and where it should be used; in 4-page pamphlet. Cheesman-Elliot Co., 639-647 Kent Ave., Brooklyn, N. Y.

Circle No. **29** *on Reply Card*

Jet Tray Deaerator

. . . to remove corrosive gases from boiler water feed; construction features and a cut-away drawing are shown in 4-page *Leaflet* 28R7980. Allis-Chalmers Mfg. Co., Milwaukee 1, Wisc.

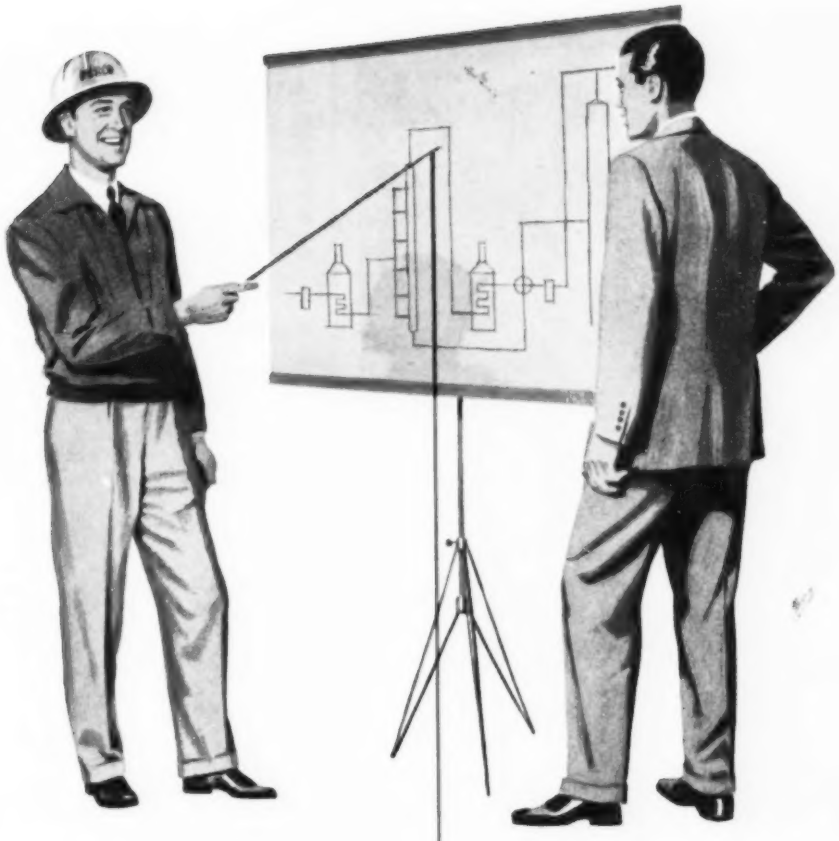
Circle No. **30** *on Reply Card*

Force Feed Lubricator

. . . described in 12-page catalog illustrating different types of application for the apparatus, and giving dimensions, performance data, shipping weights, etc. Manzel, 315 Babcock St., Buffalo 10, N. Y.

Circle No. **31** *on Reply Card*

(*To obtain more data on advertised products see page* 1232)



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Bartlesville, Oklahoma

(To obtain more data on advertised products see page 1232)

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Look for the wrench with that guarantee label to make sure you get the extra-easy work and extra durability that have made RIGID the world's most popular wrench.

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THE RIDGE TOOL COMPANY, ELYRIA, OHIO, U.S.A.

RIGID

Work-Saver Pipe Tools

What's New!

Aldehyde Products

. . . booklet, describing the 14 aldehydes now being marketed by the manufacturer, including physical properties, specifications, test-methods, uses and suggested applications; in 36-page *Booklet F-5278*. Carbide and Carbon Chemicals Co., 30 E. 42nd St., New York 17, N. Y.

Circle No. **32** *on Reply Card*

Measuring Instruments

. . . including many types of oscillographs, recorders, amplifiers, and other instruments for many industrial purposes; described in 32-page *Booklet ED-21701-30M*. Brush Electronics Co., 3405 Perkins, Cleveland 14, O.

Circle No. **33** *on Reply Card*

Chlorine Dispenser

. . . solution feed, dry vacuum type; specifications covering dispensing rates from 0.5 to 1000 lb./day in 12-page *Catalog* 61; each part of the unit is separately analyzed and discussed, with additional information on the operational performance of the apparatus as a whole. Fischer & Porter Co., Hatboro, Pa.

Circle No. **34** *on Reply Card*

Centrifugal Pumps

. . . of six types, in standard end suction class, either frame mounted or mono-block units; illustrated in 4-page *Bulletin W-300-B4*; with performance charts. Worthington Corp., Harrison, N. J.

Circle No. **35** *on Reply Card*

Industrial Thermometers

. . . in mercury-in-glass and bimetallic types; 16-page *Bulletin E-2* presents technical data and installation information on many models of both kinds, with an additional discussion on the mercury thermometer as a thermal protective device. Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.

Circle No. **36** *on Reply Card*

Beryllium Product Directory

. . . including the pure metal, its oxide and alloys; 20-page pamphlet lists forms in which metal is commercially available and discusses properties which make it valuable in certain types of industry. Beryllium Corp., Reading, Pa.

Circle No. **37** *on Reply Card*

Gear Pumps

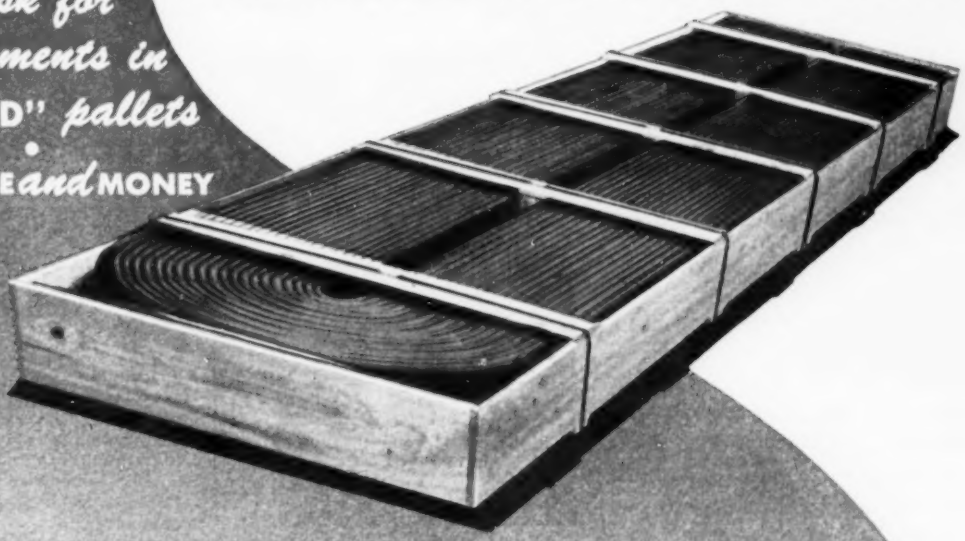
. . . for materials with viscosity ranges from 30 to 10 million SSU and with capacities from 1 gph to 1000 gpm; design, construction features and operation of manufacturer's complete line discussed in 24-page *Bulletin 17-A*. Schutte and Koerting Co., Dept. P-E., Cornwells Hts., Bucks Co., Pa.

Circle No. **38** *on Reply Card*

this is the new, improved way that Wolverine can speed your installations of CONDENSER TUBES

Ask for Shipments in "U-BEND" *pallets*

SAVE TIME *and* MONEY



Now provide yourself with a stand-by unit. Have the required replacement of condenser tubes (either plain or finned) at hand—ready for quick and efficient installation.

Arranged in a wooden pallet according to predetermined order (a whole complement of tubes, if required), the tubes can be fed as one unit directly into the condenser or heat exchanger with a great saving of time. Tube-unloading, inspection, assembly, handling and installation costs are thus materially reduced.

Each pallet is designed and constructed to suit your individual requirements. It will withstand the handling in transit. You'll receive the tubes arranged in the order you'll use them and in the perfect condition you expect them. And, too, in this condensed package form they occupy comparatively small storage space and can be easily stacked.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

ESTABLISHED 1916

Manufacturers of Quality-Controlled Tubing

1425 CENTRAL AVENUE • DETROIT 9, MICHIGAN

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

Export Department, 13 E. 40th St., New York 16, N. Y.

A Book You Should Have on Mechanical Sealing...

A complete reference catalog on Dura Seal—the engineered mechanical seal that rotates with the shaft. Amply illustrated . . . specific applications . . . installation data. A fact book of real value to designers, operators and maintenance departments.

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CALIBRATING TANKS

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REFINERIES
TERMINALS
PIPE LINES
TANK TRUCKS
LOADING RACKS
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We have built hundreds of these provers in all capacities from 50 gallons to 50 barrels. . . . This experience enables us to deliver a REAL PRECISION INSTRUMENT that is Guaranteed. Building, calibrating and guaranteeing a calibrating tank is specialized, painstaking work and is definitely "out" of the price-per-pound category. These tanks are designed to conform to the A.P.I. tentative code #1101, but may be furnished with such modifications as you, the customer, may require.

WARNER LEWIS COMPANY

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What's New!

Crystal Urea

. . . chemical and physical properties, with data on solubility and specific gravity of solutions, and a list of possible new uses; in 8-page pamphlet. Allied Chemical & Dye Corp., Nitrogen Division, 40 Rector St., New York 6, N. Y.

Circle No. **39** *on Reply Card*

Aluminum in Processing

. . . industries; 8-page brochure lists economic advantages of this metal, composition and properties of alloys, tables covering materials safely handled by aluminum, and other engineering data. Aluminum Co. of America, 808 Alcoa Bldg., Pittsburgh 19, Pa.

Circle No. **40** *on Reply Card*

Strain Gages

. . . thermocouples, and extension wire, and diaphragm motor control valves are discussed in separate articles in "Instrumentation" Vol. 6, No. 5 (1953) a publication of Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **41** *on Reply Card*

Acidproof Sump Pump

. . . for draining and filling acid tanks, chemical plant floor clean-up, etc.; specifications, illustrations and schematic drawings in 4-page *Bulletin SP-53*. The Galigher Co., 545 W. 8th St., Salt Lake City, Utah.

Circle No. **42** *on Reply Card*

Deaerating Heaters

. . . of the spray-type; 8-page *Bulletin WC-101A* explains specific functions and requirements of the units, with design description and flow charts. Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y.

Circle No. **43** *on Reply Card*

Fire Hose Eductor

. . . for proportioning wetting agents and manufacturer's "Foam" liquid; description of various models and instructions for use in 4-page engineering data sheet. Rockwood Sprinkler Co., 38 Harlow St., Worcester 5, Mass.

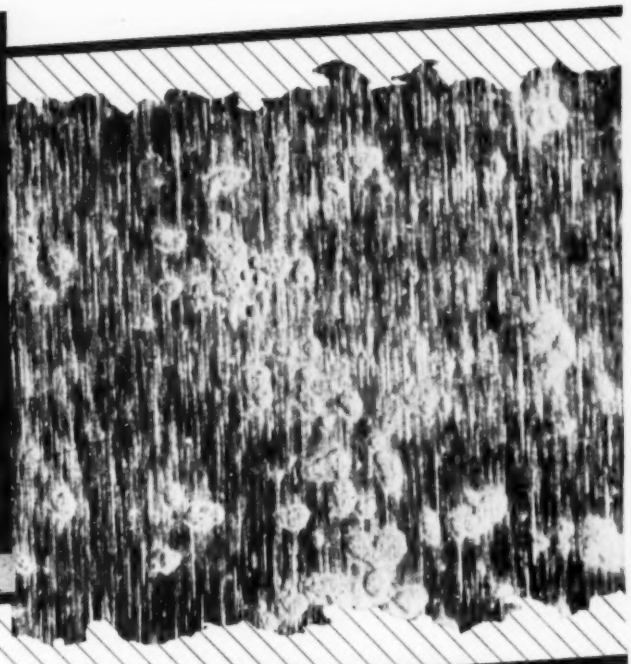
Circle No. **44** *on Reply Card*

Vertical Pump Motors

. . . with hollow and solid shafts; 8-page *Bulletin* 1250 shows various types of enclosures available for these units, with cutaway illustrations giving details on the lubricated thrust-bearings obtainable, and specific features of motor construction. Louis Allis Co., Milwaukee 7, Wisc.

Circle No. **45** *on Reply Card*

How To STOP WATER-SIDE CORROSION, PITTING and TUBERCULATION



Corrosion, pitting and tuberculation are problems which all too often plague engineers. In addition to running up replacement costs, these conditions can cause lengthy and unscheduled down-time of important plant equipment. But something can be done about these problems *now*, thanks to the Dianodic* Method developed by Betz Engineers.

For instance, a Southwestern natural gasoline plant employed as make-up for its circulating cooling water system a well water of high alkalinity. Not only was chemical attack of the tower severe, but in addition, aggravated corrosion was encountered on the heads, sheets and baffle plates of the shell and tube exchangers. Heavy tuberculation and pitting was evident.

Betz Engineers recommended the new Dianodic Method of corrosion inhibition. Upon the application of this control method, chemical attack of the cooling tower wood was stopped, and the system gradually cleaned itself of the accumulated corrosion products. Plugging troubles were eliminated. A "before and after" corrosion study with test specimens showed reduction of average penetration from 0.03 inches per year to 0.002 inches per year. Maximum pit depths were reduced to less than 1/25 the previous rate.

**Betz Service Mark*

The Dianodic Method is a system of combining two anodic inhibitors in such a way as to effectively eliminate pitting and tuberculation, and at the same time provide protection against general corrosion and scale. It is just one part of the Betz *Specialized* Water Conditioning Service for all types of water problems. Why not call in a Betz Engineer and have him tell you how Betz can help you? You'll save yourself time, money, and trouble.

W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

For complete information on the Dianodic Method write today for Betz Technical Paper No. 125.

BETZ

CONSULTANTS ON ALL WATER PROBLEMS

H.T. BLOCK INSULATION

You can pour castable refractories directly against

WEBER'S H. T. BLOCK

without waterproofing the block surface!

And that's not all; Weber's H. T. Block is:

- Resilient—for less field breakage.
- Square cut—for an easy fit and a tight fit.
- Chemically inert—for protection of insulated metal surfaces.
- Single block insulation—for temperatures from −250° F. to 1800° F.
- No special tools—for faster on-the-job application.

ASK FOR BULLETIN 501 . . . WRITE TODAY

FORTY-EIGHT INSULATIONS, INC.
AURORA, ILLINOIS

What's New

Oxygen, Combustibles Analyzer

. . . in one unit; operational features, installation requirements and available accessories given in 4-page *Product Specification E65-1*. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle No. **46** *on Reply Card*

Process Piping Plant

. . . a pictorial description of the manufacturing activities of Western Piping Supply, a division of the Lummus Co.; in 16-page booklet. The Lummus Co., 385 Madison Ave., New York 17, N. Y.

Circle No. **47** *on Reply Card*

Automatic Oxygen Analyzer

. . . of the direct reading type; advantages, specifications outlined in 4-page *Bulletin* 108. Arnold O. Beckman Inc., 1020 Mission St., South Pasadena, Calif.

Circle No. **48** *on Reply Card*

Did You Miss These?

The following, reviewed originally in June, have aroused considerable interest among readers. They are repeated briefly as a service to those who might have missed them the first time. For details or literature, use the regular Reply Card facing page 1233.

New Flow Meter Design Needs No Long, Straight Approaches

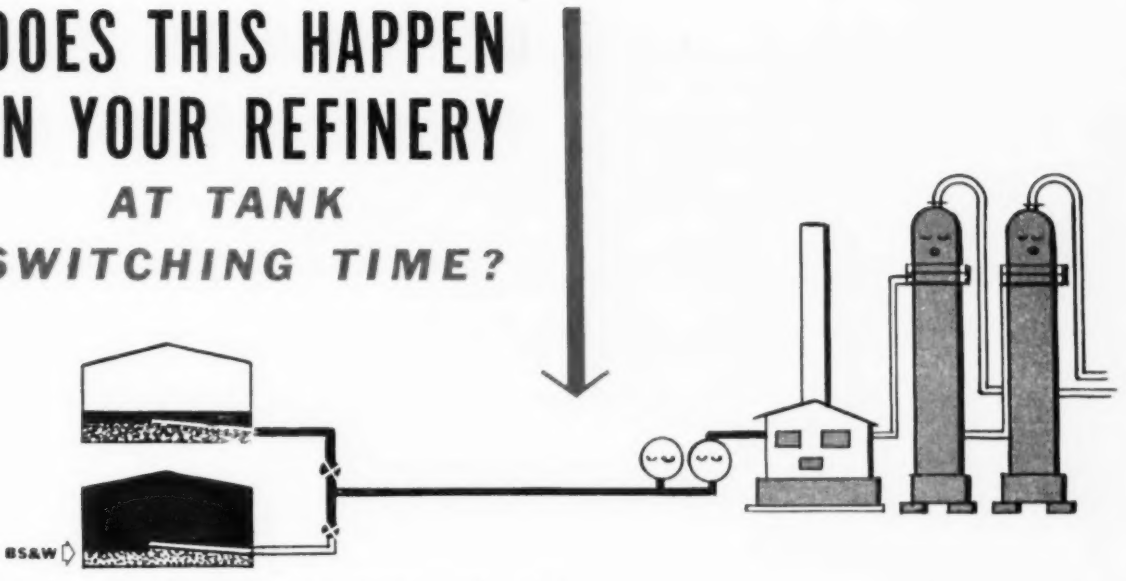
. . . or discharge lines. Eliminating the purging or freezing of instrument lines, the "Flovane" utilizes the principle of flow velocity instead of pressure drop taps. Normally hazardous fluids can be metered safely, because the fluid does not leave the pipe. Operation is as follows: A circular vane inside the flow pipe is attached to one end of a lever arm with a diaphragm and a poppet valve at the other end. The fulcrum is located at a predetermined point between the two so as to supply the required multiplication of the applied force of flow to the operation of the diaphragm. The diaphragm and poppet valve assembly, operating on the pneumatic force balance principle, allows the required amount of air pressure to balance the flow force and operate a gage. Link Engrg. Co., Flovane Div., 13844 Elmira, Detroit 27, Mich.

Circle No. **49** *on Reply Card*

Tank Gaging Can Be Handled By Ordinary Telephone Wire

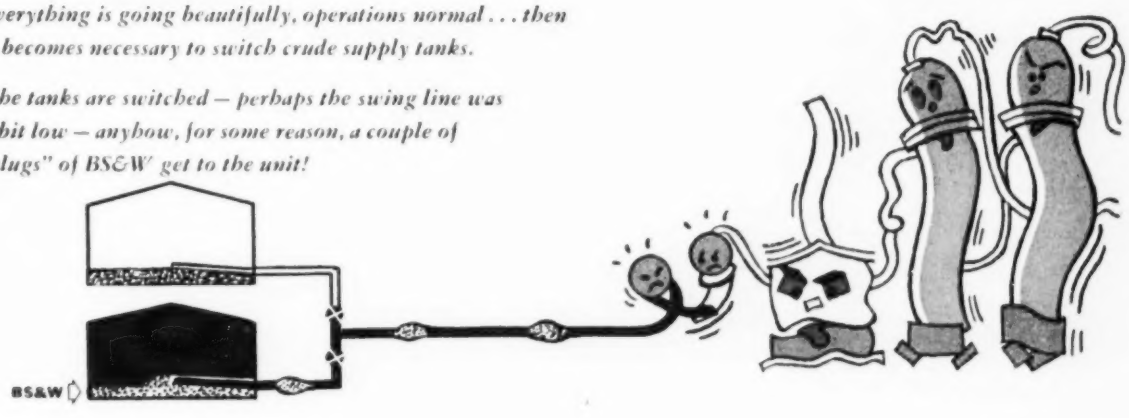
. . . without interfering with the use of the same wire for regular

DOES THIS HAPPEN IN YOUR REFINERY AT TANK SWITCHING TIME?



Everything is going beautifully, operations normal . . . then it becomes necessary to switch crude supply tanks.

The tanks are switched — perhaps the swing line was a bit low — anyhow, for some reason, a couple of "slugs" of BS&W get to the unit!



With Petreco desalting, this just can't happen. No BS&W, salts or solids get by a Petreco desalter. This benefits the refiner in two important ways:

First, the refining unit is not slugged with BS&W, salts and solids every time a tank is switched. Even if you accept only low-salt-content, pipeline specification crude, BS&W will accumulate. As long as there are BS&W settlings in storage tanks, "slugs" are possible, and as long as they are, you have a potential source of upsets, salt damage and solids accumulation.

Second, if you are careful when tanks are switched, severe damage can be delayed, perhaps avoided. But how is this done? Usually by *slowing- down, cutting-back, reducing throughput.* This means lower throughputs, fewer barrels of oil refined per calendar day. In the long run, running equipment at less than capacity is a costly practice, too!

Why not insure top refining throughput, as well as profitable efficiency, with Petreco desalting? Get Petreco's new booklet on tank switching, today. Write or call

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ELECTRIC PETROLEUM PROCESSING

CRUDE OILS: REMOVAL OF SALTS, SOLIDS, OTHER IMPURITIES; DEHYDRATING
DISTILLATES: ACID TREATING; CAUSTIC TREATING; DOCTOR TREATING
FUEL OILS: DESAPONIFICATION, ASH REMOVAL

PS 53-3

WANTED—TECHNICAL WRITER

We need a technically-trained man, under 30, for the editorial staff of PETROLEUM PROCESSING. He should have a background of mechanical engineering and experience in refining or petrochemical manufacturing operations—with emphasis on equipment. He should be able to write clearly and cleanly, and have done some work in preparing reports.

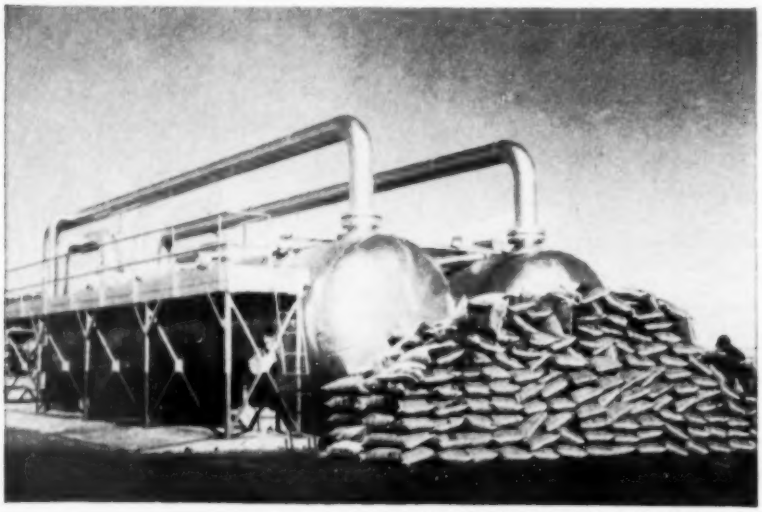
He should have an inquisitive mind and like to probe into the "why" of things, and be able to explain to others what he has found out.

Experience in magazine or newspaper production is desirable but not essential.

Duties will include editing and rewriting copy, with responsibility for specific departments in the magazine, and field trips to gather data for original articles. Location is in Cleveland, and salary is open. Send details to:

EDITOR, PETROLEUM PROCESSING

1213 West Third Street • Cleveland 13, Ohio



Gas dehydration units, San Juan Basin Plant

THE WORLD'S LARGEST
HORIZONTAL GAS DEHYDRATION UNIT OF

El Paso Natural Gas Co.

Uses FLORITE

Most economical of the granular drying agents, Florite has a longer service life, gives a low dew point depression, and aggressively resists "poisoning effects" which permanently destroy adsorption qualities.

Natural gas, propane, butane, gasoline, air, nitrogen, carbon dioxide, refrigeration compounds—and a growing list of liquid and gaseous compounds—are successfully treated with superior drying efficiency by use of FLORITE DESICCANT.

Let us prove that Florite is best suited for your desiccant requirements, too.

FLORIDIN COMPANY ADSORBENTS DESICCANTS DILUENTS

Department Y. 220 LIBERTY STREET WARREN, PA.

What's New!

conversation. The new S&J "Varioplex" system for remote liquid level measurement converts the primary values (sensed by any conventional S&J float and gage tape assembly) into electrical impulses which can be superimposed on existing telephone circuits, or may be, if desired, sent also by microwave radio. An oil company main office in New York city could, with the proper hook-up, check on a Pacific Coast tank farm. Information could be obtained in 25 seconds down to the last ⅛-in. Cost for a hypothetical installation on 12 identical tanks 50 miles from the company's offices with an existing private wire was estimated at about $7500. Manufacturer's own selsyn system, designed for similar purpose but not operative beyond two miles, would cost around $7310. Entire system is operated electrically. Shand & Jurs Co., 2630 Eighth St., Berkeley, Calif.

Circle No. **50** *on Reply Card*

Electrical Wire

. . . and cable data, compiled in a 76-page booklet *U. S. Electrical Wires and Cables for the Chemical and Petroleum Industries;* divided into four sections on insulation compounds, jacket compounds, constructions and technical data; including information on butyl insulation, heat- and moisture-resistant insulations, thermoplastic types, neoprene jackets, and the polyvinyl chloride type jacket. U. S. Rubber Co., Electrical Wire and Cable Dept., 1230 Ave. of the Americas, New York 20, N. Y.

Circle No. **51** *on Reply Card*

Tube Corrosion

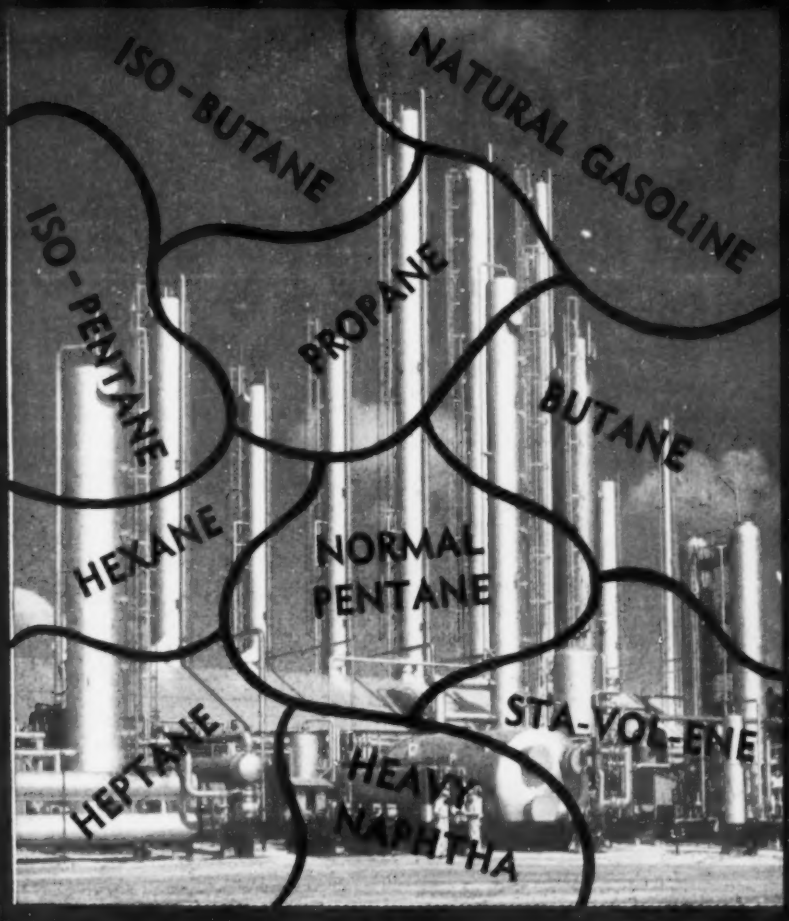
. . . in condensers and heat exchangers; booklet deals with properties of copper-brass condenser tube alloys and applications in industry plus corrosive effects: 156-page Condenser and Heat Exchanger Tube Handbook. Bridgeport Brass Co., Bridgeport 2, Conn.

Circle No. **52** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

DO THESE PRODUCTS FIT INTO *Your Picture?*



NATURAL GASOLINE
PROPANE
ISO-BUTANE
BUTANE
ISO-PENTANE
NORMAL PENTANE
HEXANE
HEPTANE
HEAVY NAPHTHA
STA-VOL-ENE

WARREN

PETROLEUM CORPORATION

TULSA, OKLAHOMA

How a military aircraft problem led to

The Greatest Gasoline Development in 31 Years

TCP* is a revolutionary new gasoline additive that stops the greatest cause of power loss in modern automobile engines. TCP additive is now blended into Shell Premium, and is available at Shell stations throughout the United States.

With the advent of high octane number fuels for peak performance of both military and civil aircraft, the problem of spark plug fouling became critical. Maximum design performance and range of the aircraft were severely limited by deposits formed on the insulating portions of the spark plugs. These deposits caused malfunctioning of the spark plug often at critical times when maximum spark plug performance was necessary. The problem was studied jointly by petroleum suppliers, engine and spark plug manufacturers, and airframe builders both from the chemical and mechanical standpoint.

Shell Research Mobilized

To tackle the problem Shell mobilized its research facilities. First step was development of a dependable test for spark plug fouling. With this test, Shell had the necessary equipment with which hundreds of compounds could be quickly tested—rejected and tested again in different formulations. Round-the-clock testing finally led to the discovery of Shell's TCP additive.

Not since the introduction of tetraethyl lead in 1922 has there been such an important development in gasoline.

How TCP additive helps existing engines—can lead to even better designs

This remarkable ingredient actually changes the nature of combustion deposits inside an engine; actually makes them harmless. Plug-shorting and pre-ignition are eliminated. Now car owners get up to 15% more power—often before using the second tankful. Spark plug life is increased as much as 150%, and gasoline mileage is improved.

Car manufacturers and dealers benefit too! New cars perform the way designers intended; new car buyers have few performance complaints. And for the future, designers can plan for higher compression and horsepower, lighter and more compact engine designs.

TCP is Shell's trademark for this additive. It is another example of the progressive research that goes forward day and night in Shell laboratories. It is evidence again that Shell research provides more and better products from petroleum.

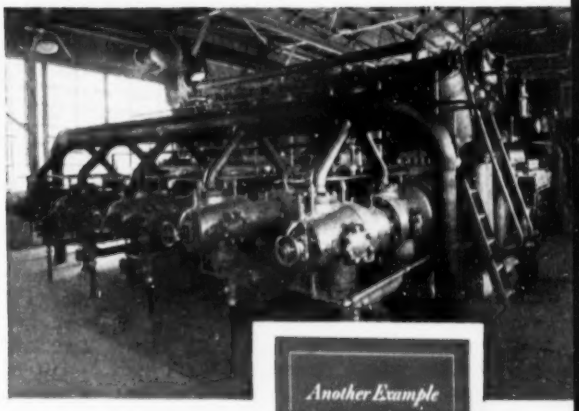
*Patent applied for

SHELL OIL COMPANY

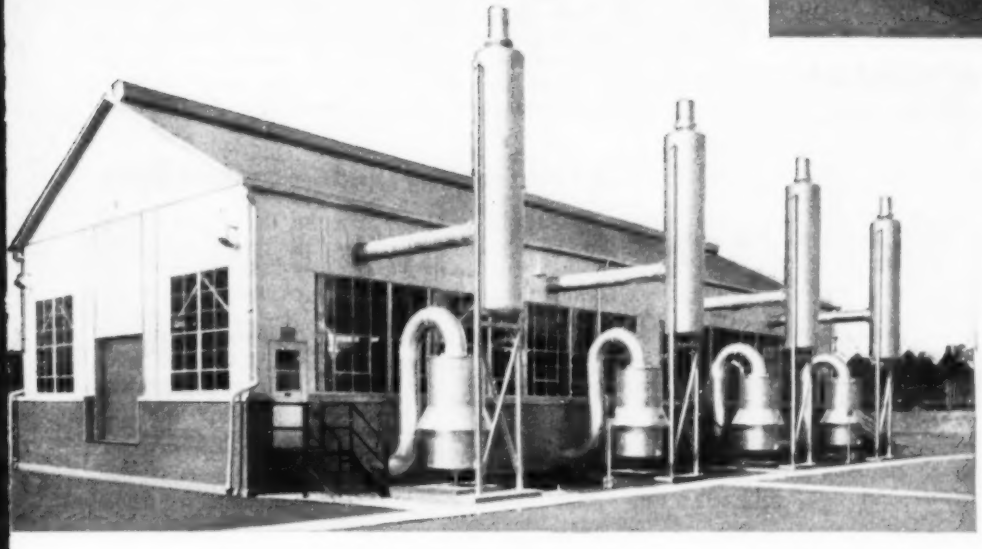
SHELL

In Oklahoma Natural's largest gas-storage project . .

. . a lot of compressing in small space with compact GMV's



Another Example of Efficient Power at Lower Cost



●Look at the size of the building . . and the neat compactness of this 4400-hp GMV compressor set-up. Here, at Depew, Oklahoma Natural Gas Company is equipped to handle approximately 160,000,000 feet per day with a suction pressure of 500# and a minimum injection pressure of 800#—a lot of compressor work with a minimum of installation and operating overhead.

Note also that these Cooper-Bessemer V-angles are driving 5 compressor cylinders per unit . . . in other words, a compressor cylinder for *every* crankthrow.

Add up the advantages you stand to gain with Cooper-Bessemer V-angles—proved month-in-month-out availability, unmatched compactness, and overall operating efficiency that has yet to be equalled! Get *all* the facts. You'll see why Cooper-Bessemer V-angles are preferred units in every type of heavy-duty compressor service.

The Cooper-Bessemer Corporation

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EDITORIALS

Oil Storage Goes Underground

THE recently announced project of Esso Standard Oil Co. to use abandoned quarries not far distant from its Bayway refinery for the seasonal storage of heating oil merits consideration, both as an industry project and as a possible factor in our defense program.

For industry use, this means of storing low volatility materials for relatively long periods, would seem to be chiefly a cooperative enterprise. The volume carried in these old stone pits would have to be large to be economically practicable, running into millions of barrels in the individual reservoir. Esso's first project, experimental to a considerable extent, involves 1,500,000 bbls. There are few single refineries whose operations are large enough to make this kind of term storage feasible. A group of refiners within an area, having quarries located convenient to common markets, might find the venture practicable.

The idea of using this type of underground reservoir for the storage of fuel oils, and perhaps gasoline, against great emergency needs, is something the heads of our national defense effort might consider. The storage of volumes of products for which the need would be large in the event of war, larger than could be supplied from current operations, has been discussed. Consideration has also been given to having volume storage capacity available for placing refinery output during a period when civilian rationing would be in effect, but before channels of supply for the armed forces would be fully opened to receive the output of refineries. The carrying of large volume of products in storage against war or other emergency needs might also lessen the pressure on the refining industry to maintain large surplus capacity to meet such needs. —V.B.G.

Salvaging for the Future

THE Synthetic Liquid Fuels experimental program on which the Bureau of Mines embarked in 1944, under the sponsorship of the Roosevelt regime, and for which $85,000,000 in public funds was authorized by Congress, wisely was terminated by the new administration. Government research work on liquid fuels from other sources than petroleum will be continued, but certainly not on the ambitious scale of the past 9 years.

Early in the program launched in 1944 it became apparent that the work was to be used by the New Dealers to propagandize for a commercial scale synthetic fuel industry in this country. The factual information and data resulting from the research in many instances was lost sight of or distorted in the publicizing, by the Mines Bureau and other government agencies, to show that recovery of synthetic liquid fuels today would be competitive with petroleum.

Over the past several years a great many scientists, most of them able and conscientious workers, carried on the laboratory research work of the program and operated the 200 b/d shale oil recovery project at Rifle, Colo., and the 200 b/d coal hydrogenation plant at Louisiana, Mo. The unbiased factual information resulting from their work is an important contribution to the technology of synthetic liquid fuels production. Now the experimental coal hydrogenation unit is being abandoned and operations at Rifle will likely be considerably modified. Many of the technologists who participated will be transferred to other activities and some will leave government service.

At some now indefinite future time we will turn to the production of synthetic fuels to supplement those from petroleum and natural gas. Then the complete reports and supporting data from the Bureau of Mines extensive program will assume more importance than today, if only as stepping stones to future development work in this field.

What is required is not essentially an appraisal of the Mines Bureau's program. This has been made by the National Petroleum Council's Committee on Synthetic Liquid Fuels Production Costs. More necessary is a complete listing, cataloging and indexing of the various projects, and the storing of the records where they can be found and made available when needed, even though in the future. —V.B.G.

Are You Getting Ideas—or Just Data

IN THE June issue of *Reader's Digest*, an article on the skyrocketing cost of air power makes the point that the U. S. Air Force's Research and Development program is perhaps producing data by the ton—but few new basic ideas.

"Our system has become too cumbersome, too intricate, too big," the author states. "Too many non-research minds in research, too many administrators in engineering. There is too much empire building. Within R & D a 'project' becomes a sort of institution that seeks to keep itself alive and growing—get a bigger budget for next year, get more personnel, set up some sub-project, perhaps become a whole 'program'.

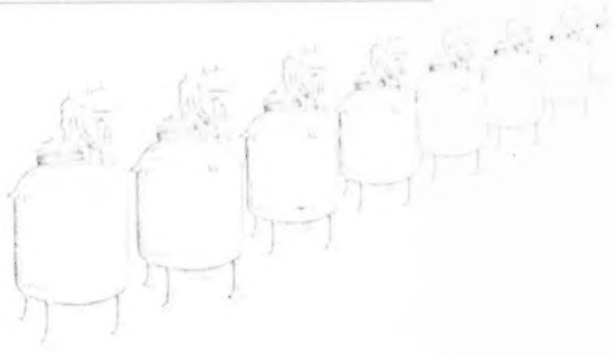
"Are we trying to bring about by supergovernment what can happen only in the dark labyrinth of man's brain? Invention comes not from institutions but from people."

The author also points out that, with respect to the Air Force R & D program, there is too much "classified" data, that we must free the flow of information and give free flow to the inventive genius of individuals if we expect to get startling new ideas. "Invention," he says, "is a spark that jumps from mind to mind. Put too much insulation around, and there are no sparks."

We aren't familiar with the Air Force's R & D program, so we aren't qualified to criticize or defend it. But it seems to us that here are some fundamental ideas which are worth pondering by every responsible person in R & D in the petroleum processing industries.

We don't believe that the above criticisms apply necessarily to R & D in our industries. But take a look at your own program. Is it getting too cumbersome and involved? Are there too many administrators—and not enough researchers and engineers? Are you getting tons of data—or basic ideas? —W.F.B.

This research chemist needs 30 ounces...



and this company needs 30 tons a year...

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So, whatever your needs—whether for high purity process chemicals or a special product custom-made to your specification—you'll find *there's no better source than B&A!*

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. . . FOR OVERSEAS DUTY

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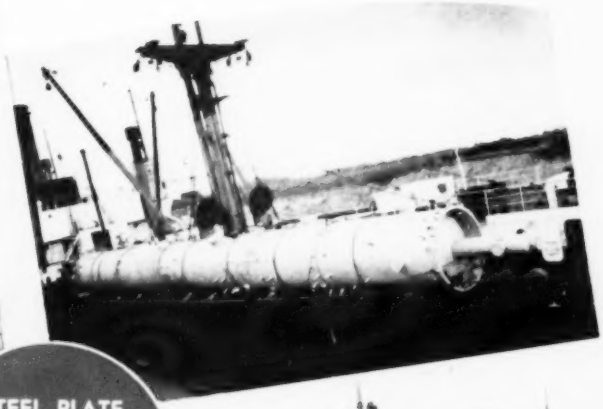
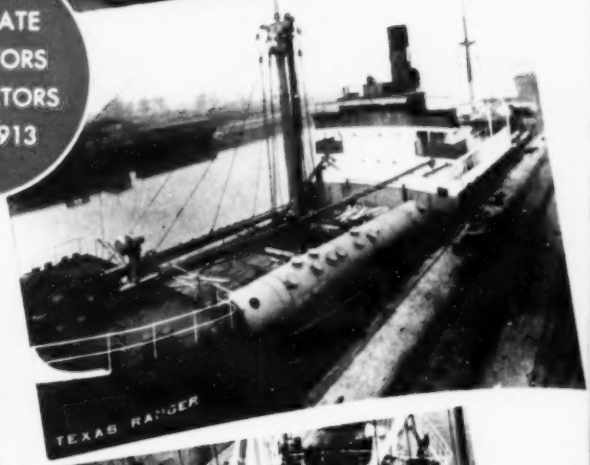
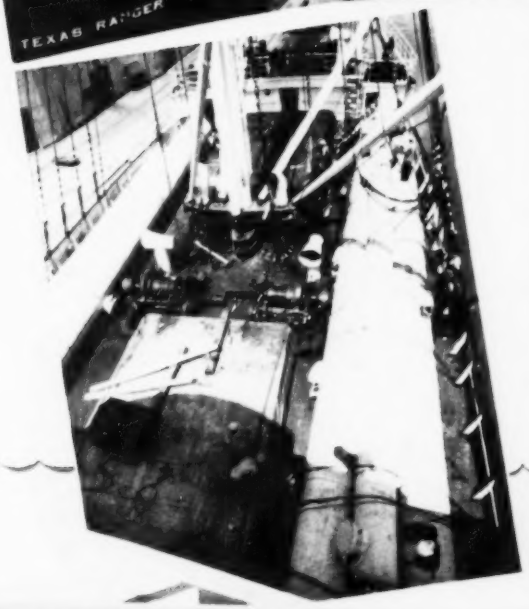


STEEL PLATE FABRICATORS AND ERECTORS SINCE 1913





Wyatt's

HOUSTON-DALLAS-NEW YORK-TULSA